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Technology Review

Edited at the Massachusetts Institute of Technology

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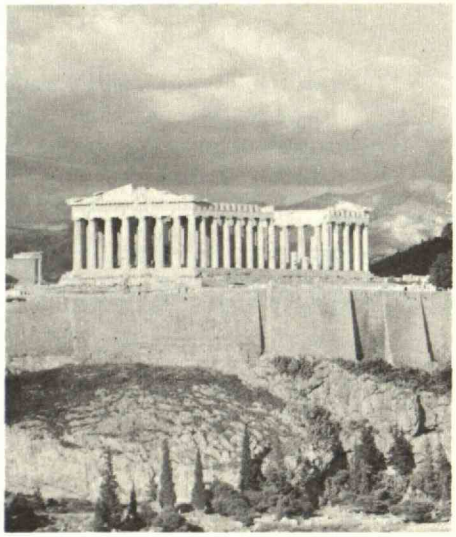

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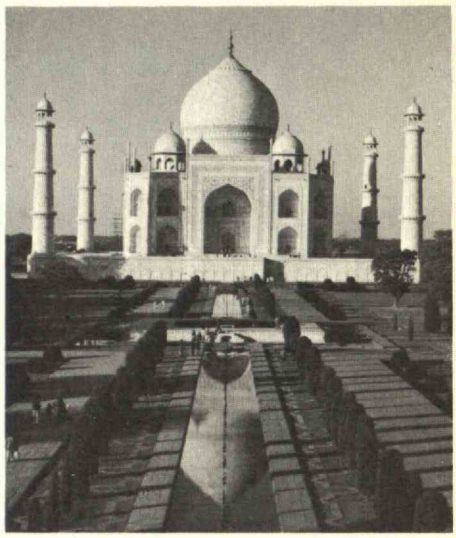

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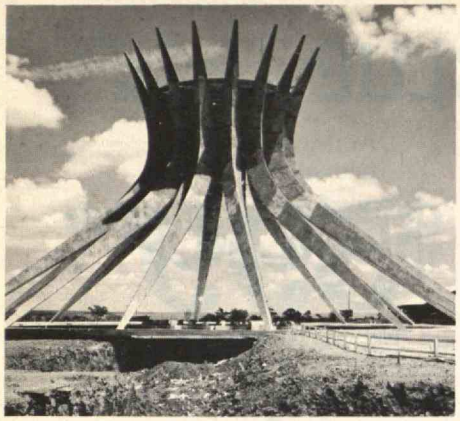

peaks of "Volcano Alley" to visit an Indian market; the great viceregal city of LIMA, founded by Pizarro, where one can still see Pizarro's mummy and visit the dread Court of the Inquisition; the ancient city of CUZCO, high in the Andes, with an excursion to the fabulous "lost city" of MACHU PICCHU; cosmopolitan BUENOS AIRES, with its wide streets and parks and its colorful waterfront district along the River Plate; the beautiful Argentine LAKE DISTRICT in the lower reaches of the Andes; the spectacular IGUASSU FALLS, on the mighty Parana River; the sun-drenched beaches, stunning mountains and magnificent harbor of RIO DE JANEIRO (considered by many the most beautiful city in the world); the ultra-modern new city of BRASILIA; and the fascination of the vast Amazon jungle, a thousand miles up river at MANAUS. Total cost is $2325 from Miami, with special rates from other cities. Optional pre and post tour visits to Panama and Venezuela are available at no additional air fare. Departures in January, February, April, May, July, September, October and November 1975.

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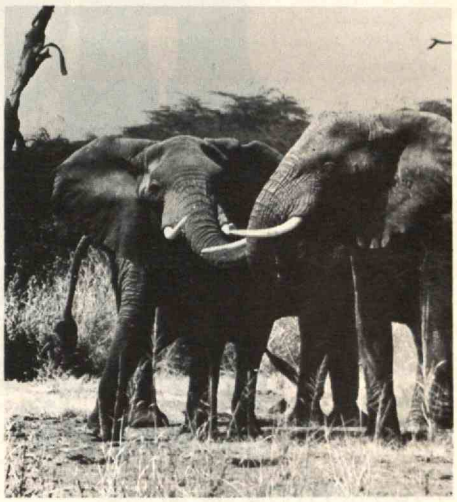

PARK; the spectacular masses of pink flamingos at LAKE NAKURU; black-maned lions and multitudes of plains game in MASAI-MARA RESERVE; the vast stretches of the SERENGETI PLAINS, with leopard, cheetah and large prides of lions, as well as great herds of zebra, wildebeest, and impala; the permanent concentrations of wildlife on the floor of the NGORONGORO CRATER; tree-climbing lions and herds of elephant along the shores of LAKE MANYARA; and the beaches and tropical splendor of historic MOMBASA on the Indian Ocean, with its colorful old Arab quarter and great 16th century Portuguese fort, and with optional excursions to LAMU or ZANZIBAR. The program also includes a visit to the famous excavations at OLDUVAI GORGE and special opportunities to see tribal dancing and the way of life of the Kikuyu and Masai tribes, as well as the great safari capital of NAIROBI. Optional post-tour extensions are also available to ETHIOPIA and the VICTORIA FALLS. Total cost is $2100 from New York. Departures in January, February, March, May, June, July, August, September, October, November and December 1975.

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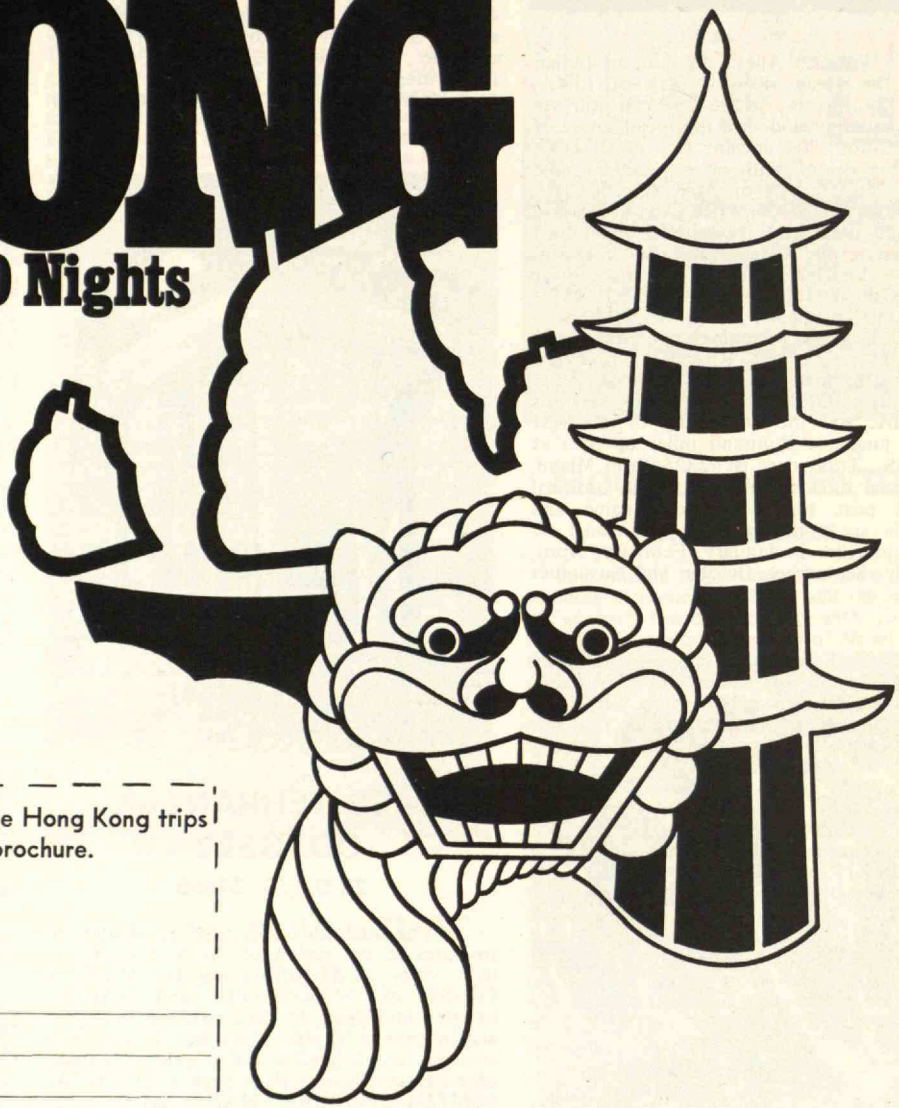

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Letters

What Is Knowledge?

Kenneth E. Boulding *("A Technology for Educational Art?," June, p. 10)* says we have an ever-increasing "stock" of knowledge which is to be transmitted to future generations and which will ultimately overwhelm the educational process. He therefore calls for "the artistic community to be mobilized in the interest of learning."

But what is knowledge? William James says that "knowing" is a particular sort of relation between two portions of "pure experience." I take it that the only way to learn is by "experiencing" — that is, by doing — and I suspect that the old cliché, "those who know do and those who don't know teach," is true.

The teaching process should be a form of apprenticeship or internship. The genuine seeker after knowledge should have direct contact with the knower and doer and should become involved in the process. The introduction of a third person — the detached educator — is therefore useless; and no amount of help from the artistic community can save him. Paul Rudolf, who was Dean of the Yale School of Art and Architecture in the 1960s, is quoted as saying, "If you closed every architectural school tomorrow it would make no difference," and Frank Lloyd Wright — who derided all architectural schools — set up his own at Taliesin where students in residence learned by doing.

Education must be synonymous with participation. The process must be simplified, and ultimately the entire community must become involved in some aspect of it.

Silvio Zanetti
Cambridge, Mass.

Environmental Architecture: "Fentestic"

Bruce Anderson's review of *A Bucket of Oil (March/April, p. 67)* reminded me of a story about a convocation conducted at M.I.T. on environmental architecture. The panel was originally scheduled to consist of a distinguished group who were to fly in at the last minute. As luck would have it, the plane was forced down on a small uncharted air field and could not be repaired in time for the panelists to meet their commitment. After hurried deliberation, the committee arrived at a solution: they would form a panel out of young people recently graduated from the Institute and — out of deference to the older generation — they would invite one 50-year-old alumnus to sit on the stage.

In turn the moderator asked each participant, " . . . and what did you learn about environmental architecture at M.I.T.?" First, a B.Arch '70 went into a beautiful discourse on the dangers of oversimplification, ending with, "Simplicity is the most deceitful mistress. . . ." Everyone applauded. When decorum was reestablished, the moderator looked at the older alumnus, who looked back and said into the microphone, "Fentestic."

Then an S. B. in Aero. and Astro. '70 presented his magnificently organized thesis on the convenience and flexibility of digital computers in the day-to-day solution of the equations of Newton, Bowditch, and Carnot and its future impact on the understanding of transparent surfaces in structures ending with, " . . . We must examine the choice of window glass in many more contexts than that of reduction of summer heat gain alone." Thereupon the audience burst into wild applause. After five minutes the moderator quieted the audience and looked again towards the older member. "Fentestic," he said as he looked out into the hall.

The third member of the panel to speak was an M.Arch '73. "Architecture is a dying profession," he cried out over the tumultuous applause as he finished. Once again silence and the same exclamation from the end of the table, "Fentestic."

And so it went on, member by member, and after each contribution, "Fentestic." Finally, the moderator turned condescendingly to the gentleman on the end, who by this time had folded his hands on the table and was staring out over the convocation with a hypnogogic look. " . . . and what, sir, did you learn when you were at M.I.T.?" Silence once again reigned over the hall as the overwhelmed alumnus whispered into the microphone, "At M.I.T., I learned physics, mathematics, thermodynamics . . . some humanities. I learned a great many important things which have influenced my professional career. But, most important, I learned to say 'fentestic' instead of 'bullshit.' "

Joseph Schneider (S.B., M.I.T. '49)
Boston, Mass.

Humans vs. Birds?

Ian C. T. Nisbet *("Pesticides and Breeding Failure in Birds," June, pp. 8-9)* would have been more helpful if he had indicated exactly how many rare and useful birds, if any, were in danger of extinction due to D.D.T.

Animals in the wild are subject to insults and stresses from egg collectors, hunters, automobiles, jet plane noises and from a variety of deadly and long-lasting poisons, any of which could account for thinning of eggshells. Consider the case of the bald eagle. Since 1964 these majestic birds, when found dying or dead, have been frozen and sent to the U.S. Fish and Wildlife Service Laboratory in Laurel, Maryland, where the chemicals in their tissues are analyzed. Of 34 birds with sufficient chemicals in them to kill, 22 contained toxic amounts of thallium, two of mercury, one of lead, and eight of dieldrin. Only one out of 34 contained excessive D.D.T. It would be strange if D.D.T. were the main cause of eggshell thinning, since D.D.T. has been declining in use for the last 14 years. Well over 70 per cent of all American eagles die unnatural deaths due to bullets and deliberate poisoning.

Nisbet's contention that "persistent toxic chemicals" are harmful to mammals is open to question, at least in the case of D.D.T. and man. Workers in D.D.T. factories are less likely to contract cancer than the general population. Volunteers fed D.D.T. for long periods of time show no ill effects.

The Audubon Society, with which Dr. Nisbet is associated, attempted to ban the export of D.D.T. to India. There, millions of lives are being saved through the use of D.D.T. as an antimalarial agent. It is sad to see a few scientists and a wealthy and powerful organization more concerned with the protection of a few predatory birds than with the health of millions of humans.

Cyrus Adler
New York, N.Y.

True Rulers of the West

As Professor Kindleberger points out *("Lessons from 1929 for the Petro-Dollar Problems," May, pp. 46-55),* it is clear that the mantle of world leadership is of little value to its bearer except as a member of the world community. Such benefit always collapses when the "free riders" revolt from what they perceive as oppression. The only secure leader or ruler is one whose leadership is covert. Britain was the obvious leader prior to 1930, and the U.S. is seen to have assumed this position after World War II. But I contend that the Swiss have been the true rulers of the western world for some hundreds of years.

David L. Wiesen
Newark, N.J.

Entropy Is Coming

On behalf of my grandchildren and my later descendants, I thank Dean Earl Cook for his informed and reasoned jeremiad on the state of the planet's resources and their inevitable depletion *("The Depletion of Geologic Resources," June, pp. 14-27).* Entropy is coming — of that my philosophy allows no doubt. However, this would not condone mere passive acquiescence or failure to exert every effort to postpone the inevitable as long as possible. We do nothing less in the analogous situation of our own lives.

Arthur J. Morgan
New York, N.Y.

The *Monitor's* Blacksmith?

There might be another link between the *Monitor* and M.I.T. *(see "The Monitor Is Found" by Harold E. Edgerton, February, pp. 8-9).*

In 1926 a course taught by James R. Lambirth in the now-extinct Forging Laboratory was required of students in mechanical engineering. "Pop" Lambirth

was then alleged to be the oldest man on the faculty, and his opening lecture was a demonstration of the art of hand forging, an incredible performance with touches of showmanship by a master craftsman and artisan. No one slept through that vaudeville show! I was fascinated.

I later caught him in his office to ask how and where he had learned his art of ironworking, and he supplied colorful details of his early years in the Mississippi delta country fashioning the intricate wrought iron fences and rails and balcony gingerbread for which the area is famous.

When I asked how he was started in forging, he recounted a tale of having been apprenticed by his father to a shipyard blacksmith to learn the trade at a tender age. They were building a ship under great need and pressure. The blacksmith had immediately set the new boy to knocking up square heads on bars that someone else threaded into bolts. Maybe I had heard of the ship? It was the *Monitor.*

I wonder if, next time, Professor Edgerton and his cohorts could fish up for the Institute one of those square-headed bolts perhaps made by one of its faculty.

James C. Reddig, '29
Webster, N.Y.

Put Everything in Boxes

I wish that the authors of "Technological Change in the Food Industry" *(December, 1974, pp. 20-29)* had emphasized the lack of standardization in packaging as the curse of automatic handling in the future.

"An actual account in a retail distribution warehouse showed 2,587 different size shipping cartons in a dry grocery section stocking 5,000 items," they write. And that is only the warehouse. Think of the differences in size and shape of the items themselves. The industry has only itself to blame for letting it get out of any semblance of uniformity over the years. Drastic changes will be required for the fully automated supermarket. Tin cans will disappear. Everything will be packaged in square or rectangular plastic containers that can ride through the assembly-line machinery. Soup, bananas, bread, you name it — they will all be boxed. I would be surprised if more than 50 different sizes will be permitted for 5,000 items. Food manufacturers will have to conform to the limited packaging, and the buying public will have to become accustomed to less variety in size and shape.

The article states: "The typical automated market concept involves the display of one of each kind of item behind a glass door. The customer places a card in a slot which activates selection of the product from a warehouse section of the store and its transfer to the front end for customer payment and acceptance." I would add automatic bagging at a central pickup point. This will be possible with everything in boxes.

Franklin J. Walsh
Washington, D.C.

Toward a Mathematics of Social Problems

Special Report
by
George A. W. Boehm

Of what earthly use is higher mathematics? Taken literally, this is not an absurd question. The answer depends on who is asking it and why.

The kinship of mathematics with the physical sciences and modern engineering is obvious. In fact, starting about the time of Isaac Newton, they all grew up together. The relationship is almost mystically close. When Albert Einstein was searching for mathematical ways to express his intuitive ideas about relativity, he found the tools he needed ready-made by pure mathematicians.

Elsewhere, mathematics has paid slighter and less conspicuous dividends. It has scored limited successes in a few other fields, notably economics. Three recent Nobelists, Paul Samuelson, Kenneth Arrow, and Wassily Leontieff, take mathematical approaches to problems. Nevertheless, these men are more highly regarded for their insights and worldly wisdom than for the elegance of their mathematics, which is within easy grasp of a college math major.

Nor has mathematics done much to alleviate the great social problems of the day. Mathematicians have contributed nothing important to ecology or protection of the environment. So far, they have had little to say about the long-term effects of the green revolution upon peasant societies. And they are no more clever than others in devising ways to reverse urban decay.

Yet, mathematicians working on a limited number of social problems have accomplished enough to suggest that they could achieve still more by broadening the focus of their logic and intellectual discipline. So it is that a concerted effort to determine how mathematics can benefit society is now underway. In January, 1973, the Society of Industrial and Applied Mathematics (S.I.A.M.) formed a subsidiary scientific corporation called S.I.M.S.(which stands for S.I.A.M.'s Institute for Mathematics and Society) — in mathematical parlance, a case of "nested acronyms." S.I.M.S. is eliciting the kind of financial support from foundations and government agencies that might well be denied individual mathematicians. Indeed, substantial grants have been made by the National Science Foundation.

The driving force behind S.I.M.S. is Donald L. Thomsen, Jr., its president. After completing his Ph.D. in mathematics at M.I.T. in 1947, Dr. Thomsen began an academic career, then switched to the Applied Science Division of I.B.M. Before resigning from the company in 1972, he was for five years I.B.M.'s Director of Engineering Education. Hence his special interest in the project. In his soft-spoken but intense fashion, Dr. Thomsen is a supersalesman of the intellectual ideas behind S.I.M.S., arranging conferences and workshops, assembling speakers, and, when necessary, even attending to such details as running slide projectors and tape recorders.

A Cocktail-Party Activist Becomes Committed

Perhaps the most innovative and exciting of S.I.M.'s activities is its so-called Transplant Program. Under this scheme, a young but highly-trained mathematician (typically an assistant or associate professor) will work full time for two years in an interdisciplinary center that concentrates on social problems. The basic premise is that even a genius may need many months to understand the issues well enough to make individual contributions toward solving them. After the two years are up, the transplant, of course, has the option of returning to pure or applied mathematics. But Dr. Thomsen hopes to select the sort of men and women who will continue to be interested in using their skills to benefit society. They will have to be bold enough to gamble with their careers at a critical time when most young academics are worrying about promotions and tenure, and good enough to be confident they will succeed in a strange new field.

The first transplant was James C. Frauenthal, an assistant professor at Tufts who in September, 1972, became a fellow at the Harvard Center for Population Studies. The intellectual transition was drastic. Dr. Frauenthal acknowledges that his first love is academic problems, the kinds in which a mathematician can exercise his virtuosity without bothering with the messy uncertainties and imperfections of the real world. "You can ignore the data or take them for granted, almost like axioms," he explains.

"On the other hand, I am personally deeply concerned with the problems of society, and I don't want to be just a cocktail-party activist. I can see how my mathematics, applied to real population problems, gives me a unique opportunity to contribute something to human welfare."

As his term drew to a close, Dr. Frauenthal was still spending most of his time and effort learning the complexities of human populations. Yet by November, 1973 he had co-authored a highly technical paper on a new way of calculating "life tables," which predict the probability of a person dying at a particular age.

"An Indispensable Period of Maturation"

Wherever future transplants are assigned, they and their hosts are likely to encounter initial confusions in language. Dr. Frauenthal, for example, soon learned that a "stable" population is one with a growth rate of e^{rt}, with r, the ratio among age groups, being a constant. To a mathematician, such a population seems to be anything but stable.

At some centers, the transplant's hosts are likely to be disappointed if their visitor does not immediately begin to solve problems. Such an expectation, however, is unrealistic. When a mathematician speaks of "applied mathematics," he does not mean the kind of mathematics that easily solves workaday problems. So the term "applied mathematics" as used by mathematicians is fully as deceptive as the use of the word "stable" by demographers.

The success of transplants in their new careers is likely to depend more on their method of approaching problems than on the kit of mathematical tools they have acquired. Andrew Gleason of Harvard, an ethereally pure mathematician, has occasionally done some industrial consulting. Although he has been generally successful, he claims never to have solved a problem that required more than "elementary" — that is, college-level — techniques.

Transplants will also have to be flexible enough to master the new disciplines to which they are assigned. Dr. Norton Nelson, Director of the New York University Institute of Environmental Medicine, foresees "an almost indispensable period of maturation, of understanding between the experimentalist and mathematician . . . A mathematician coming into a new field of biology cold . . . is going to have to allow himself enough time to collect some ideas, to try out some ideas, and to discard some ideas . . . against the accepted canons of science. The accepted canons may be wrong, but I think he has to know how to deal with them if he is going to survive."

A Calculus of Hidden Variables

In its present stage, the program is in a position akin to the infant computer industry almost 20 years ago. At that time, many salesmen made a pitch that went roughly as follows: "Your scientists and engineers are going to need our computer. Of course, it will take them several months to learn to use it efficiently. But meanwhile you can make the machine pay for itself by handling the payroll." As it usually turned out, the scientists and engineers within a week were lined up, waiting for computer time. But it took a year or two to straighten out the payroll, for the clerks who had been doing the work carried in their heads dozens of special cases and exceptions that bedeviled any logical program. Similarly, particular social problems may prove intractable, while broad questions of strategy and policy are more easily resolved.

So far, conferences and workshops have provided mathematicians with a sense of the issues they will confront and of the conceptual modifications that will be necessary. Frustrations abound:

— Many problems fall into an awkward area where details are too numerous to be handled as individual interrelated phenomena, yet too few to be gathered in statistics or calculus.

— Data are often either unobtainable or unreliable, so the mathematician who wants to do a thorough job must consider the cost of performing experiments — or turn to other means, such as computer simulation.

— Some of the most important variables are hidden in the background of human activity. A team of social scientists and mathematicians may devise a theoretically perfect way to distribute policemen throughout a city. But they must humbly realize that they have wasted their time unless they can gain the approval of some city official, and his attitude may depend upon how he thinks the new method will influence his chances of promotion or reelection.

— Some logically optimal solutions are worthless because they violate antitrust laws or labor contracts. A noted research mathematician at a leading operations research center once prescribed the best schedule for loading and unloading trucks at a large company. He suggested that the drivers and their helpers work split shifts and do some of the jobs ordinarily assigned to electricians. Yet if this "perfect" solution had been adopted, every union man in the plant would have gone on strike.

Given adequate financial support, the whole S.I.M.S. program — conferences, workshops, and transplants — promises to attract many able mathematicians. Some, particularly the transplants, may change fields and become social, behavioral, and biological scientists. But senior mathematicians holding eminent positions in universities or industry will be unlikely to start their professional lives all over again, so for them, different arrangements are possible: extended sabbaticals or joint appointments in mathematics and some other department.

In the long run, S.I.M.S. may have greatest appeal for those regarded as second-rate mathematicians with first-rate minds. The attendance at the first conference in 1973 suggested as much, for most mathematicians there came from colleges and universities that do not grant doctorates in mathematics.

Mathematics has its share of dropouts who major intensively during college, then turn to some other field. Many were first attracted to mathematics because they liked puzzles and problem solving; they became disenchanted when they learned that top-ranking mathematicians, both pure and applied, work mainly on a highly theoretical plane. So perhaps the most useful mathematical work on human problems will be done by people whose intellectual loyalty is split between the rigor and logic of mathematics and the rough and tumble of an almost hopelessly confusing real world.

George A. W. Boehm is a distinguished free-lance science writer and a member of the Advisory Board to Technology Review.

The S.I.M.S. Transplant Program has aroused widespread interest and enthusiasm among both mathematicians and institutions. A partial list of study centers that have indicated they could use transplants includes:

— Stanford Medical School Department of Genetics, in the study of population genetics and cultural evolution.

— California Institute of Technology Hydraulics Laboratory, in research on water quality and the stability of coastlines and coastal structures, including pipelines and moored ships.

— California Institute of Technology Air Pollution Laboratory, which has been pioneering in the analysis of complex smog aerosols.

— Cornell University Center for Environmental Quality Management, concerned with human epidemics, population theories, and systems approaches to ecological and environmental problems.

— Harvard University School of Public Health, which includes the management and administration of health service institutions, environmental health science and engineering, and tropical public health.

— Princeton University Center for Environmental Studies.

— New York University Institute for Environmental Medicine.

— New York City/Rand Institute, which works with various departments of New York City government on improving policies as well as day-to-day operations.

Doers and Stoppers

Technology/Society
by
Kenneth E. Boulding

The distinction between sins of omission and commission is a very ancient one in ethics and theology. I suspect it has been forgotten, especially in virtuous circles, but that is precisely when it becomes important. The trouble is that sins of commission are visible and sins of omission are not.

Law and regulation deal primarily with sins of commission. Sins of omission are harder to deal with. How does one punish a person for failing to do something? Here reward is more effective than punishment.

One of the great virtues of the market is that it rewards people for providing desired goods and services. The market also has punishments: if you produce something for which there is not sufficient demand, you lose capital. That punishment is swift and automatic; it requires no palaver or ritual of the courts. And if you fail to produce something for which there is demand, you will have missed an opportunity. In that sense there is a sanction which again involves no intervention by the courts.

Market Values, Social Goals

The great complaint against the market, of course, is that demand should not be the only criterion of production. Market demand depends on the distribution of income, but the demands of the rich may be socially less desirable than those of the poor. Demands may also be addictive, like the demand for heroin, and perhaps for automobiles, and market response would be injurious to the demander. Some demands may produce spillover effects which are incompatible with the sanctions of a pure market system.

Quite legitimate political controls have been imposed on the market: differential taxes, licensing, prohibitions, regulations on product quality. We further recognize that monopoly will distort the structure of rewards and punishments in the market and so must be destroyed or regulated.

These considerations prompt an important question too little exposed to public debate or concern: is the legal system's increasing concern with sins of commission producing a pathological growth in sins of omission? There is evidence of an emphatic shift in the direction of the legal system here and in other countries from *caveat emptor* — let the buyer beware — to *caveat vendor* — let the seller beware. The change is subtle and has slipped in without much discussion. It could have important consequences. One sees it at work, for instance, in the spectacular increase in malpractice suits, in consumer legislation, in the great number of court decisions awarding damages to purchasers of defective products, in the environmental protection movement, and so on. One can sympathize with much of this: the trouble with *caveat emptor*, ultimately, is that the buyer tends to be more ignorant than the seller and is likely to fall victim to the seller's sins of commission. Because the buyer may not readily be able to detect defects in what he is buying, he needs protection by some kind of public regulation or organization.

The Expense of a Secure Purchase

There must be a point, however, at which the protection of the buyer is carried too far. Then the attempt to correct sins of commission leads to the producer's failure to do anything at all, simply because the costs of uncertainty and honest mistakes are unbearable.

Whether we have reached this point in our own society, I do not know — but I worry about it. I grew up in a culture that assumed that if something were wrong with you, it was your fault, and if not, it was somebody's else's. The great virtue of this ethic is that one usually has a better chance of correcting one's own defects. We now seem to be assuming that if anything is wrong, it is most likely someone else's fault. This often has the disadvantage of leading to windy preaching and bellyaching rather than corrective action. Even when the assumption does lead to corrective action, however, there is grave danger of overdoing it. Perhaps we are close to, or even beyond, this critical point today.

It is, unfortunately, very hard in practice to distinguish between honest mistakes and deliberate evil. No one would deny that society should discourage deliberate evil — that's what law is mostly about. If, however, the sanctions against evil are too severe, they may be applied against honest mistakes, as well, to the point where nobody will be willing to do anything or take any risks. The problem is somewhat analogous to one in the theory of signal detection: if we try too hard to avoid "misses" (that is, not detecting the signal when it is there), we will cause too many "false alarms" (that is, detecting the signal when it isn't there). So it seems that we must tolerate a certain amount of evil in order to encourage people to take the inevitable risks involved in doing good.

Can consumer protection be carried too far? And at that point will producers simply cease to provide the goods and services we all need? (Photo by Roger N. Goldstein.)

If we had a law that anybody who drilled a dry oil well would be shot, very few wells would be drilled. Our tolerance of dry wells does not seem to extend to research projects, which are always expected to gush; to doctors, whose treatments must always cure; to teachers, who must never fail a student; and to manufacturers, who must never sell a defective product.

So it may be that the epitaph of our society will read: "Died of extreme accountability."

Kenneth E. Boulding is Professor of Economics and Director of the Institute of Behavioral Science at the University of Colorado.

Trend of Affairs

Trends This Month

TELEVISION 10

Extending the capacity of a much-abused medium.

FOOD 13

A tendency toward benign neglect abroad . . . and a harvest of technology for farms at home.

ENERGY 14

From garbage dumps to gas lines . . . from sewers to streams. . . . Energy conservation begins at home (again). . . . Retrieving energy from farms and forests.

Video-disc television players could revolutionize the home study industry, allowing visual presentation of information. Since a home video-disc player could be stopped, replayed, or the picture frozen, the learning experience could be much better than with current broadcast educational television (photo courtesy Philips-MCA).

Television: An Adolescent Matures

Just as certainly as television has profoundly affected our society, it has profoundly failed to realize its full potential. A medium with a multitude of available channels uses only a few; those that are used are reduced to carrying only programs that will attract the most bodies to the set. Television represents a dictatorship of the majority. What's more, the massive, expensive equipment necessary for broadcast-quality television makes the medium relatively studio-bound.

A number of technologies being developed around the world promise to revolutionize this underused medium. Among these developments: video-disc players that can play cheap phonograph-like records through a television set; video magazines in which any one of hundreds of "pages" of information can be selected by the viewer; and ultra-small, potentially cheap television cameras that could record events as easily as the reporter's pencil. This is not to mention the increase in satellite communications; cheaper television sets; cable television; increased television surveillance; and other extensions of present technology certain to have their impact. The following illustrate the changes to come.

Round and Round They Go

Even a child could operate the video-disc players to be marketed next year, say the manufacturers. The players, which feed television signals from 60-minute phonograph record-like discs into television sets, could allow unprecedented freedom in home television viewing (photo courtesy Philips-MCA).

One pitched battle in the consumer electronics industry over the next few years will be between RCA Corporation and a partnership of MCA, Inc., an entertainment conglomerate, and N. V. Philips, a Dutch electronics corporation.

These two competitors plan to market systems late next year for playing phonograph-record-like video-discs on a $500 player attached to the home television set. The possibilities for such a system are enormous. Not only could viewers select any program they wished, no matter how esoteric (or erotic), but home study would boom. Do-it-your-selfers could actually *see* how the whatzit attaches to the whozit; medical students could play and replay their favorite operations; massive amounts of information could be cheaply stored on the high-capacity discs for use in the home, government, industry, or academe.

The catch is that RCA and MCA-Philips have come up with two different and incompatible methods for home TV records. RCA relies on a sensitive needle tracking a tiny spiral groove as the record spins on a 450 r.p.m. turntable. The video picture and sound signals arise from the changes in electrical properties as the stylus speeds through the grooves.

Philips and MCA combined their formerly rival technologies to develop a system based on a laser beam in the home player. As the disc spins at 1800 r.p.m., the finely-focused blue beam bounces off a succession of tiny pits arranged in a spiral on the record's surface; the resulting reflections constitute the signal for the television. In producing a disc that could store about 30 minutes of television per side, both RCA and MCA-Philips have developed systems capable of storing tens of billions of information bits, and both can give stereo sound along with a high-quality color picture.

The systems represent remarkable achievements, and certainly promise to out-perform the once highly touted videotape players, which have settled at prices too high for the average consumer — $1000 for a player and $30 per 30 minutes of taped program.

The two companies are making subtle and not-so-subtle jabs at one another even before entering the marketing ring. For instance, RCA claims that its system will be reliable and cheap because it is fabricated from conventional components that have been on the market for many years. The sturdy stylus can be replaced as easily as a phonograph needle. No complex beam-aiming mechanism is needed for the needle-in-groove system. And the lower rotational speed significantly reduces the possibility of vibration in the system, say company spokespersons.

Philips-MCA counters with the assertion that all its components have been mass-marketed for years: advanced optics systems in cameras; integrated circuits in computers, lasers in office, military, and space equipment; and high-speed discs in computer storage units. Optical equipment allows higher storage capacity, say company engineers. Philips-MCA has achieved a storage density that could permit up to 60 minutes playing time per side. Because nothing touches the disc and the "pits" are protected by a layer of plastic, the record will last indefinitely. On the

Incredibly small television cameras are among the developments which will affect the future of television. Here a Bell Laboratories engineer holds the first solid-state television camera that meets the requirements for commercial broadcast use. In his left hand is the imaging sensor, called a charge-coupled device, that made the camera possible (photo courtesy of Bell Labs).

other hand, RCA video-discs lasted through about 500 plays, as does the RCA stylus; RCA says that's as many times as anybody would want to play anything anyway.

Philips-MCA has another ace up its sleeve: although both systems can scan the record to replay a desired segment, only the Philips-MCA laser system can freeze the picture — by scanning the same groove again and again. This means that, with the high information capacity of discs, huge amounts of printed information could be put on a single video-disc, with one page per picture frame. The user could search out a page merely by punching in its address on advanced machines to be developed later.

According to the company, the entire Encyclopedia Britannica and all its supplements could easily be stored on a single disc. Philips-MCA systems with computers attached could also be used as teaching machines. The student would proceed through a teaching program, and as his progress warranted, the computer would call up one or another video instruction sequence on the player.

As an interesting aside, Philips-MCA plans to produce laser-read audio records to be played on its system. The scratch-proof disc would allow up to 15 hours of noise-free stereo per side. Remarkably, the disc capacity is so great that each instrument in a 100-instrument orchestra could be recorded on its own separate channel.

MCA also has access to the enormous film library of its subsidiary Universal Pictures, and plans to produce new programming for video-discs once the system is on the market. Whether or not the film library, containing over 11,000 titles, will be an advantage is questionable. Will people pay up to $10 to see movies and television repeats readily available on commercial television? Certainly "Francis the Talking Mule," one MCA offering, will not find a large following.

Whichever system is triumphant, "narrowcasting" — as Philips-MCA calls it — will enable an unprecedented freedom of choice in television viewing. — *D.M.*

Telemag

While video-discs could certainly become major means for entertainment and instruction, traditional television will still remain the medium of choice for up-to-the-minute news. However, even this is due for considerable improvement, as evidenced by a British experiment to produce a computerized television magazine for the home viewer.

By transmitting digital signals on the unused top two lines of the television picture, the British Broadcasting Company has been beaming 24 pages of continually updated news and information into British homes. The signals are decoded by a special computer unit which can be ordered with a viewer's set. The information system is unlike current cable television efforts at news and weather, which involve scanning a news service output or weather instruments.

The B.B.C. has dubbed its system "Ceefax," while its competitor, the Independent Broadcasting Authority, calls its system "Oracle." The systems are identical and can be utilized by the same computer decoder attached to the television set. With such specially-equipped "tellys" British viewers can use hand-held units similar to pocket calculators to call up any page at will — in effect, electronically "thumbing through" their magazine. Once a page is chosen, the computerized decoder waits for the desired page to be transmitted, and builds it up in its memory for continuous display on the screen.

The digital information transmitted does not itself "paint" scanned television lines as would normal transmission; this would require too much computer memory in the decoder, since the entire page must be stored in computer memory before being displayed.

Each transmitted information unit consists of a coded signal to the computer to form an entire character, greatly reducing storage requirements for the system and speeding the display process.

The B.B.C. plans to ultimately make available 100 pages of information, consisting of 24 lines of 40 characters each. Thus, a television viewer could obtain up-to-the-minute news, weather, food prices, stock quotations, or any other rapidly-changing information.

The key to the telemagazine's success will be whether people will be willing to subscribe, which involves purchasing a decoder as part of one's television set. The decoders presently cost over $1,000 and must be ordered specially, but according to a recent study of possibilities for the system by Financial Times Business Enterprises of London, mass-production could bring the cost down to about $100 in the 1980s. This precipitous drop is not unusual in other industries relying on electronic microcircuitry, as is evidenced by the recent drop in calculator prices. The result could be a $350 million industry in the U.S. in the 1980s. And, points out the British study, "The new service will bring computer technology into the home on a significant scale for the first time . . . and at this stage, it is impossible to predict the long-term uses it may be put to." — *D.M.*

The Eye Extended

Americans are used to having scenes from half a world away with their breakfast.

By all indications, television in the future will become even more adept at poking its eye into other people's business, and one dramatic indication of things to come is the recent announcement of new tiny television cameras.

Two companies now developing ultra-small cameras are RCA Corporation and Bell Telephone Laboratories. Both companies are using advanced image sensors, called charge-coupled devices, to produce television cameras no larger than a person's fist, operating with very little power and potentially costing less than a journalist's used typewriter.

The charge-coupled device is essentially a single chip of silicon covered with an array of electrodes. These convert incoming light images into electrical impulses, replacing the electron beam scanners in present-day television cameras.

RCA has already demonstrated both black-and-white and color cameras using charge-coupled devices, and has offered the black-and-white camera to industry for development. It is currently developing a cigarette-pack-size TV camera for use in outer space. According to the company, while the image sensor — the major component of the camera — costs several thousand dollars, a cost of $30 by the 1980s is quite possible.

While RCA has not yet achieved broadcast quality with its miniature cameras, Bell Laboratories has with its black-and-white camera. In an announcement in June, Bell Labs said that it is exploring the possibilities of using the charge-coupled device not only in its Videophone system, but also in telephone transmission systems. — *D.M.*

Nutrition Assistance: Learning When to Be Idle

Nutrition science, once the preserve of home economists, has become the domain of planners, systems analysts, social scientists, and mathematicians. This radical shift, altering both the nature and direction of the discipline, has had a major impact on foreign aid programs, changing attitudes of both donors and recipients.

Every instinct of a professional planner is to unilaterally formulate programs and then export technicians to conduct them. But Martin J. Forman, Director of the Office of Nutrition in the U.S. Agency for International Development (A.I.D.) urges restraint. Though no nutrition assistance program can be successful without economic growth and social change in the recipient country, such development cannot be imposed by the donor. The massive export of experts and expertise threatens to involve the donor agency in internal politics that are none of its business and can in the end become counterproductive, Dr. Forman told an M.I.T. workshop sponsored by A.I.D. this summer.

The more intelligent course, he said, is a policy of guided self-help; and it is just such a policy upon which A.I.D. itself is building its programs.

Such a policy involves several imperatives:

— Aid programs should never interfere with local conditions, except as the recipient nations feel compelled to change those conditions on their own to insure the success of a program.

— Though developing countries should be aware of available assistance monies, aid must be granted only upon request.

— Countries receiving aid must develop their own programs and train their own personnel to implement them. Of course donors must be prepared to offer technical assistance, but should work only with and under the foreign governments seeking their help.

— Nutrition plans and the analysts who develop them must be flexible, leaving room for the dynamics of changing local tastes (*see box*).

To Marion Frazão, Nutrition Coordinator for the A.I.D. mission to Brazil, Dr. Forman's second imperative is the most difficult to live with, though perhaps most important. "So many times we confront situations where we'd like so much to help but must wait to be asked. It's an extremely difficult position to be in. I think the major lesson for nutritionists is to learn to stand back and wait."

In keeping with the growing enlightenment of nutrition planning, and the growing involvement of recipient nations in developing their own planning mechanisms, the Ford Foundation has made a conscious shift away from U.S. research bases and is devoting its resources to sponsoring research in developing countries, says Werner Kiene, Program Officer for the Ford Foundation's Agricultural and Nutritional Programs.

Dr. Nevin S. Scrimshaw, Head of the Department of Nutrition and Food Science at M.I.T., was back from a tour of the Far East in time to add his observations on the changed emphasis in bi- and multi-lateral nutrition aid planning: "Local governments must bear the responsibility for implementing aid funds, not outsiders." In fact, Dr. Scrimshaw saw an even more radical problem: "So many times," he says, "the technicians and scientists exported to the developing countries were markedly inferior to their native colleagues. That makes no sense at all."

"Even the most backward country I visited — Bangladesh — has great potential to solve its nutrition problems. In all the developing countries, political will to take steps and political awareness of the need for just and equitable distribution are the key components. Where will and awareness can be demonstrated, other seemingly intractable factors can be surmounted." — *D.McG.*

Farm Productivity: Try a Massive Dose of New Technology

Though agricultural science and engineering have pushed U.S. food production to efficiencies which could not have been predicted even two decades ago, and though almost all of the cropland withheld from production by federal subsidy programs is now back in use, a series of reports to the American Association for the Advancement of Science this winter

Planning for Change in World Food Plans

Remember fish protein concentrate — the panacea of the 1960s for the world's malnourished?

Only one plant — in Sweden — is now producing F.P.C. There is no world industry, no vast commerce between developed and developing nations.

What about the "protein crisis" — the clamor for new protein resources that followed the discovery of the permanent mental disability which can result from serious protein deficiency in children? Low-cost, high-protein foods — such as Incaparina in Central America — have never had a substantial impact in meeting any nation's food needs. Despite the promise of high-lysine corn, there is no significant acreage of this valuable product anywhere in the world.

Even the "Green Revolution" — the new strains of wheat and rice which multiplied grain production throughout Asia — seems now to have limits: it is a high-energy agriculture, dependent on large inputs of fertilizer and water, and the rising price of energy is a threat to its success; its reliance on simple varieties of crops presents a genetic hazard; and it has brought specialization in which large farms have displaced small peasants in many parts of Asia.

From this dismal history, Martin J. Forman, Director of the Office of Nutrition in the U.S. Agency for International Development, draws four lessons for modern nutrition analysts and planners:

— There are no panaceas — no simple, easy solutions to world food problems. Never have been, never will be.

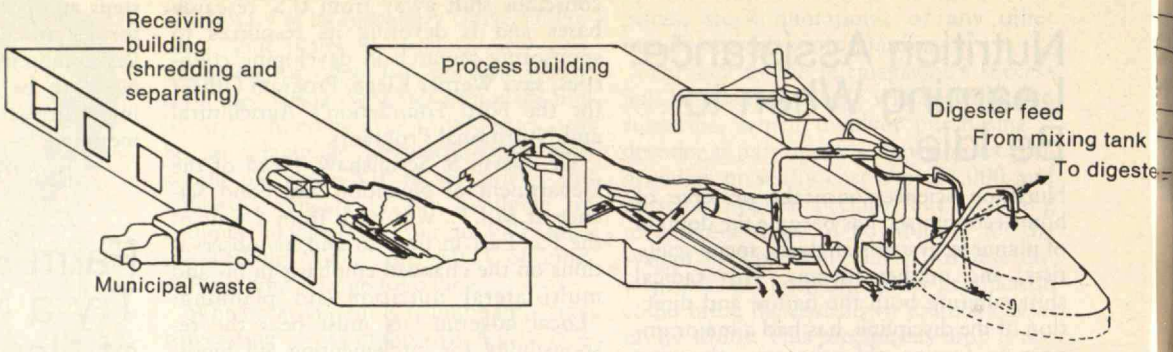
— There are no universal solutions, no assurance that what helps one country will also help its neighbor.

— There will be no quick resolution of world food problems. No matter how promising, a new development will not bear fruit overnight, nor in one year, nor even two.

— And, most important of all, food and nutrition are a dynamic system involving changing sciences, changing tastes, and changing conditions. Plans must be flexible, and planners must be flexible, too.

If nutritionists can learn these lessons, Dr. Forman told M.I.T.'s International Nutrition Planning Program at its annual dinner this summer, there will be no limit to the significance of the analysis and planning which they are now being asked to do. Already a "tentative and tenuous" beginning is being made in this new, fundamental effort; nutrition is being made an integral part of health planning, agricultural programs, and even economic development plans in many developing countries. If nutritionists can be flexible, patient, and yet activist ("How sure can you afford to be before you do *something*?" asked Dr. Forman of his audience of nutritionists from M.I.T. and Latin America), their work can in fact make a difference.

— *J.M.*



suggests that significant increases are still possible in U.S. food productivity.

Indeed, the prospects are so bright that Sylvan H. Wittwer, Director of the Michigan Agricultural Experiment Station, wants a "massive 'Manhattan Project' program in agricultural science and technology."

Here are some suggestions from a day-long symposium at the A.A.A.S. annual meeting in New York:

— Today the U.S. uses some 472 million acres of land for crops — including pasture. But an inventory by the Department of Agriculture identifies over 800 million acres as suited to cultivation of at least certain crops and under certain conditions, and some 260 million acres of land not now farmed seem to have "potential for regular cultivation," according to Melvin L. Cotner, Melvin D. Skold, and Orville Krause of U.S.D.A.'s Economic Research Service. If 97 million acres of this resource can be brought into use by 1985, grain sorghum acreage could double, cotton and citrus acreage could increase by 65 per cent, soybeans by 30 per cent, corn by 20 per cent. The scenario includes a decrease of 60 million acres in pasture — and therefore somewhat constrained beef production.

— Perhaps half of the grain harvested in the U.S. is lost to rodents and birds, according to Stanley E. Charm of the New England Enzyme Center at Tufts Medical School, and Donald Whitaker of the U.S. Bureau of Commercial Fisheries. The ideal conditions for storing grain (and also for fresh, whole fish) are high pressure and low temperature — perhaps 3,500 p.s.i. and 2° C. Those conditions are hard and expensive to maintain on land — but they occur naturally in the depths of the sea off much of the U.S., and wheat and fish could be stored there in flexible film containers with far less loss than we now experience.

— There are great variations in the efficiency with which plants convert solar energy into food energy — but the average food crops capture less than one per cent of the energy they receive. "Biological limits for productivity have not yet been realized — or even delineated," said Dr. Wittwer, and he proposed "a major investment in research on bioconversion of solar energy through the photosynthetic process."

— Consider the potential of new food products, said Gary H. Heichel of the Connecticut Agricultural Experiment Station. An example: "Extraction, coagulation, and drying of plant juices from alfalfa forage yields a concentrate that is 40 to 50 per cent protein and suitable for human food after refining." Other possibilities: single-cell protein harvested from bacteria growing on cellulosic plant wastes, sugar made from the stalks of grain-barren corn.

— Can efficient technology be found for upgrading the protein content of forages and agricultural wastes so that these can be used as animal feed? Dr. Wittwer thinks so. Only 10 to 15 per cent of the nation's corn crop is currently harvested as silage; but with appropriate additives whole corn is a completely adequate diet for beef cattle. When alfalfa is air-dried in the field it may lose as much as 500 lbs. of digestible protein and 350 lbs. of sugar per acre; agricultural processing presents many opportunities for new technology.

— Plants recover only about 50 per cent of the nitrogen and 30 per cent of the phosphate in fertilizer — "notoriously low for a resource so important," thinks Dr. Wittwer. Research in plant genetics might show how to develop more efficient varieties.

— New "minimum-tillage" farm systems save time and energy by planting crops in unplowed fields; to realize the full potential of this system we need new herbicides — another important research goal, said Dr. Heichel.

Listening to these — and a score or more other — ways in which technology might help increase food resources, Robert H. White-Stevens of the Bureau of Conservation and Environmental Science at Rutgers University was impressed; he thought it a demonstration that agriculture, in terms of productivity, quality and efficiency, can in fact "advance in the next 25 years as much as it has in the past ten millenia." "We can now 'hold a finger in the dike' through a world population of perhaps 10 to 12 billion — to the year 2025," he said.

But beyond that he finds the outlook "bleak and Malthusian." The problem is that productivity advances algebraically while population grows exponentially. "Even the most optimistic advances in world food production, including all feasible conventional techniques and all presently imaginable unconventional methods, cannot hope to do more than delay the ultimate debacle beyond the year 2075 when at present rates of proliferation the human population will approach 50 billion.

"This is a population level clearly beyond the capacity of the planet to sustain," said Dr. White-Stevens. "The extraordinary success of modern agricultural science has certainly stayed the day of execution," he said, "but it has not and cannot prevent ultimate disaster unless population itself is restricted." — *J.M.*

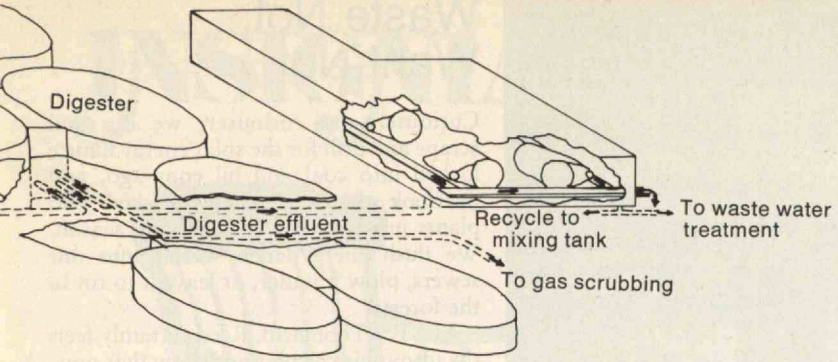
ENERGY

Fooling With Mother Nature

Fermentation is one of nature's basic methods of breaking down organic materials. In fact, it is said that the major source of methane in the atmosphere is the digestive processes of cattle.

Proposals for hooking cows to the nation's gas lines aside, a number of studies are showing that economic pipeline quality gas can be produced industrially from wastes.

Three scientists from Dynatech Corp., Cambridge, Mass., estimate that methane could be produced from municipal solid wastes for about $2.09 per thousand cubic feet, which compares well with present intrastate gas prices of about $2.00 per thousand cubic feet. And who knows what the future will bring? The engineers' analysis shows that waste-produced gas costs can range from 75 cents to $2.75 depending on who owns the plant — industry or government — and the cost of capital. Using a computer to optimize their proposed thousand-ton-per-day solid waste facility, D. L. Wise, R. G. Kispert and S. E. Sadek found that 89 per cent of the solid waste could be digested in a flow-through fermentation process. The



Dynatech Corp., Cambridge, Mass., figures it can produce natural gas from fermented waste at competitive prices, with the production plant diagrammed here. (Drawing courtesy of Dynatech Corp.)

rest could be incinerated or sent to a landfill.

The recipe for gas from waste: first, separate inorganic materials from the refuse stream, then dilute the stream with water, and add nutrients and control chemicals to keep the fermentation bacteria active. Nutrients are supplied by sewage sludge, and control chemicals are lime and ferrous salts.

The gaseous product of fermentation is a mixture of methane and carbon dioxide with traces of hydrogen sulfide, the latter two are removed with special absorbent chemicals.

Each proposed thousand-ton-per-day facility would need a population of 500,000 people to generate enough waste, according to the analysis; 65 urban areas satisfy these population requirements, and the nation could support 200 such plants.

The plants could satisfy an average 9 per cent of the gas requirements of these urban areas, or to put it more dramatically, 30 per cent of the projected gas shortages expected this year in these areas.

More information on the economics of waste-to-gas is certain: the Energy Research and Development Administration has recently funded a two-million-dollar waste-to-gas plant in Pompano, Fla., capable of processing up to 100 tons of garbage per day. The plant will operate for two years to study economic and environmental aspects of the process, and may go into actual pipeline gas production later.

In fact, it appears that the garbage we have already discarded can be tapped for gas. Southern California Gas Co. has just begun using gas from wells drilled into a 172-acre Los Angeles landfill. A plant operated by NRG NuFuel of Newport Beach, Calif., uses a molecular sieve absorption process to separate methane from other gas components, producing one million cubic feet per day, at prices "competitive with California and out-of-state natural gas," says a gas company spokesman.

And the Los Angeles Department of Water and Power is already generating 200 kilowatts of electricity to burn the lower quality gas directly from a landfill in Sun Valley. — *D.M.*

. . . And Zapping Her Creatures With Electrons

Conversion of waste to energy is certainly promising, but a more immediate, mundane problem of most cities is how to disinfect sewage wastes to render them harmless enough to inject into waterways, or to use as fertilizer landfill.

To this end, engineers from M.I.T. and High Voltage Engineering Co., Burlington, Mass., are constructing an experimental 100,000 gallon-per-day plant to bombard sewage with high energy electrons.

The test facility represents the culmination of several years of laboratory research, in which it was found that high energy electrons could kill practically all the organisms in sewage samples.

Such treatment could be far more effective than treatment methods now in use. It could kill viruses and other organisms not affected by chlorination, and could break down organic chemicals, reducing the oxygen demand of sewage effluent. The high energy electrons could also penetrate solids in sewage to kill organisms not reachable by chemical treatment. The investigators expect energy use to be low enough to make the method economical, and certainly lower than that required for baking the sewage sludge, a technique now being used in Milwaukee, Wisc.

Electron treatment would be superior to gamma ray bombardment, also proposed for sewage disinfecting, because there would be no danger of producing radioactivity in the effluent, and no need to handle or transport radioactive elements.

The experimental plant, being built at Boston's Deer Island sewage treatment plant, will consist primarily of a high-energy electron accelerator similar to those used to vulcanize rubber, sterilize medical equipment, and treat skin cancers. The accelerator's electron beam will be directed into a pressure chamber ten feet long and eight feet in diameter, through which the raw sewage will flow. The experimenters will vary the flow rates, oxygenation, and other parameters of the system to find the most effective way to kill sewage organisms.

M.I.T. scientists involved in the National Science Foundation-sponsored project include Professor Anthony J. Sinskey and Dineshchandra N. Shah of the Department of Nutrition and Food Science; Professor Edward W. Merrill and Steven R. Sommer of the Department of Chemical Engineering; and Professor John G. Trump and Kenneth A. Wright of the Department of Electrical Engineering's High Voltage Research Laboratory. — *D.M.*

Saving Money on Home Heating

With the winter heating season almost upon us, homeowners are once again reflecting upon the villainy of Jack Frost, a pocket picker as well as nose nipper.

Fortunately, a number of recent government and industry studies have detailed the steps a homeowner can take to conserve heat, and, better still, have measured energy and dollar savings resulting from those steps. Since nearly one-fifth of the nation's total energy budget is used in the home, and over half that in space heating, savings in this area please the politician as well as the pocketbook.

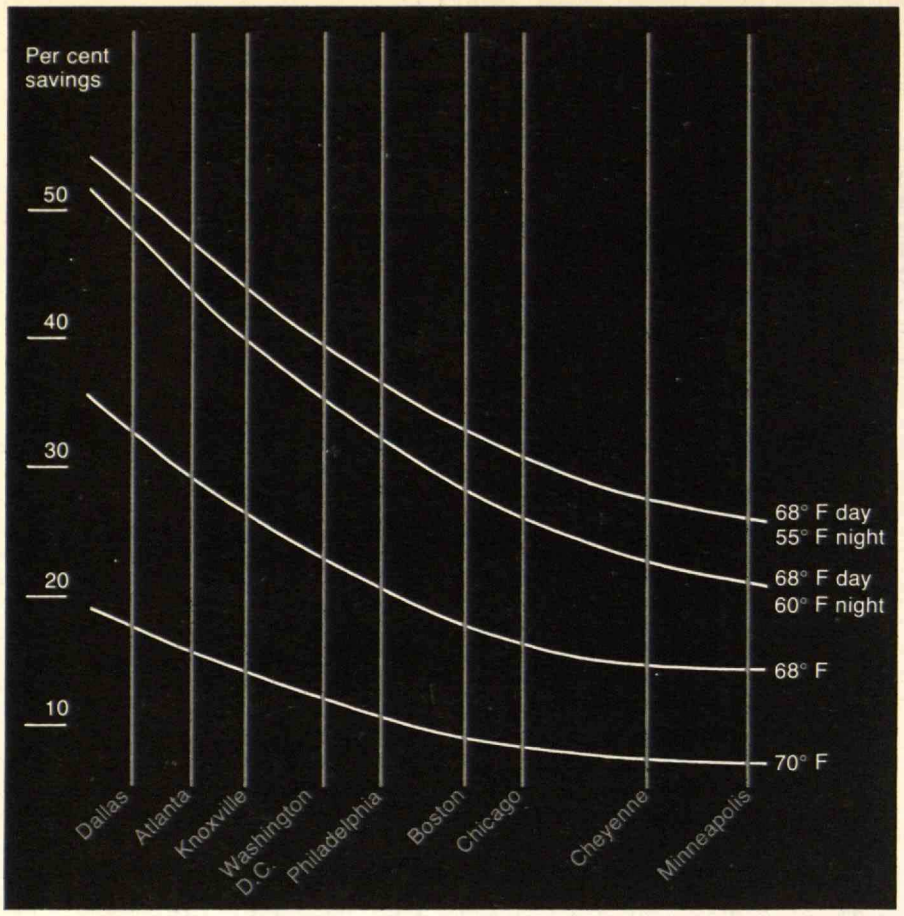
Here is a sample of the measures a homeowner can take to lower heating bills, beginning with the least drastic:

Turn it Down

Lowering the thermostat from 72 to 68 degrees during the daytime, and to 55 at night could save the homeowner from 25 to 55 per cent on heating bills, depending on where he lives, according to a study by researchers at Holifield National Laboratory (*see graph*). Researchers found that further nighttime setbacks from the 68 degree daytime reduction could nearly double the energy savings realized from the initial reduction.

The Holifield researchers pooh-poohed the widely held belief that nighttime reductions don't save much energy because more energy is required to heat the house up the next morning.

If everybody used such settings, said the



Find the city closest to you on the graph above, follow the vertical lines upward, and you will see what percentage of energy you would save by lowering your thermostat from 72 degrees. (Data: Department of Commerce)

researchers, the U.S. could reduce its energy consumption by about 4 per cent, or the equivalent of one-fourth of U.S. petroleum imports. The scientists did not say how it would be decided who got up first in the morning to turn up the heat.

Stuff Your Walls

Increasing the amount of insulation in walls and floors, and installing weatherstripping, storm windows, and storm doors could be quite profitable to the majority of homeowners in this country, according to a study by the Department of Commerce. The Department has just issued a home energy conservation guide, "Making the Most of Your Energy Dollars in Home Heating and Cooling," available from Superintendent of Documents, Washington, D.C. 20402, 70 cents, publication number C13.53:8.

The booklet is based on an earlier technical study of home insulation in which researchers found that 6 inches of attic insulation is simply not enough for most houses. In fact, 9 to 12 inches of attic insulation in oil-heated homes will generate the greatest savings, except in mild climates, and 12 or more inches could be economically justified in all-electric homes.

An interesting sidelight from the energy conservation booklet: most people believe that a tightly-sealed, well-insulated house does not allow enough fresh air in, and, thus, open a window. But in most houses 70 to 100 per cent of the air is exchanged with the outside hourly, and only a 20 per cent hourly change is needed for normal ventilation. "It is most unlikely that an existing house could be sealed up that tightly by these energy conservation improvements alone," according to the booklet.

. . . And Build Differently

In building a house, there are energy-conserving advantages in using 2 x 6-inch wood studs, 24 inches apart in house framing, rather than 2 x 4s, spaced 18 inches apart, according to the National Forest Products Association. This allows six inches of insulation in the walls. Such a house, built in Little Rock, Ark., with 12 inches of ceiling insulation, used only 39 per cent of the energy for heating and air conditioning as similar houses in that area. Besides the considerable monthly utility bill savings, the smaller air conditioner needed to cool the house saved the builders about $300, almost enough to offset the added costs of better construction, said an association report on a cooperative effort of Arkansas Power and Light Company and local home builders. — *D.M.*

Waste Not, Want Not

Curiouser and curiouser: we dig and scrape and drill for the solar energy nature locked into coal and oil eons ago, and overlook the solar energy locked into plants just over the last growing season. We flush energy-laden wastes into our sewers, plow it under, or leave it to rot in the forests.

M.I.T.'s Thomas B. Reed certainly feels the irony; his calculations show that presently collected or collectible biomass in the U.S. could satisfy about 10 per cent of our total energy consumption, and with efficient collection and conversion we could harvest from our farms and forests energy *equal* to our total present demand, plus satisfying our needs for food and fiber.

Dr. Reed outlined the methods for doing this to the Eighth Cellulose Conference, in Syracuse, N.Y. Although a limited amount of recycling of waste materials is now being done, and several plants are burning municipal refuse for electricity or steam, much more is possible, said Dr. Reed.

For one thing, we waste enormous amounts of energy in leaving behind unused portions of our harvests — for every ton of pulp or lumber harvested in Maine two to four tons are left behind in the form of brush and nonharvestable trees. This waste and farm wastes could be harvested for $7 to $20 per ton; at $16 per ton this is a cost-per-energy equivalent half that of natural gas.

To convert this biomass we could use the same processes nature uses to make coal and oil — anaerobic digestion or fermentation, acid hydrolysis, or enzymatic digestion. And the leftover sludges from these processes could be burned or used as fertilizer. Also, several commercial processes exist that use fire or heat to pyrolize wastes and produce solid, liquid, and gaseous fuels.

Dr. Reed is especially interested in conversion routes to methanol, for he is currently investigating the use of methanol as an alternative automotive fuel. His studies of present processes indicate methanol could be produced from coal, wastes, or wood at costs of about 14 cents, 25 cents, and 14 cents per gallon respectively. This compares with a 38 cents per gallon present cost of methanol. But even these prices are probably not advantageous enough to attract investors, believes Dr. Reed, although energy price rises will certainly make the processes look more attractive. — *D.M.*

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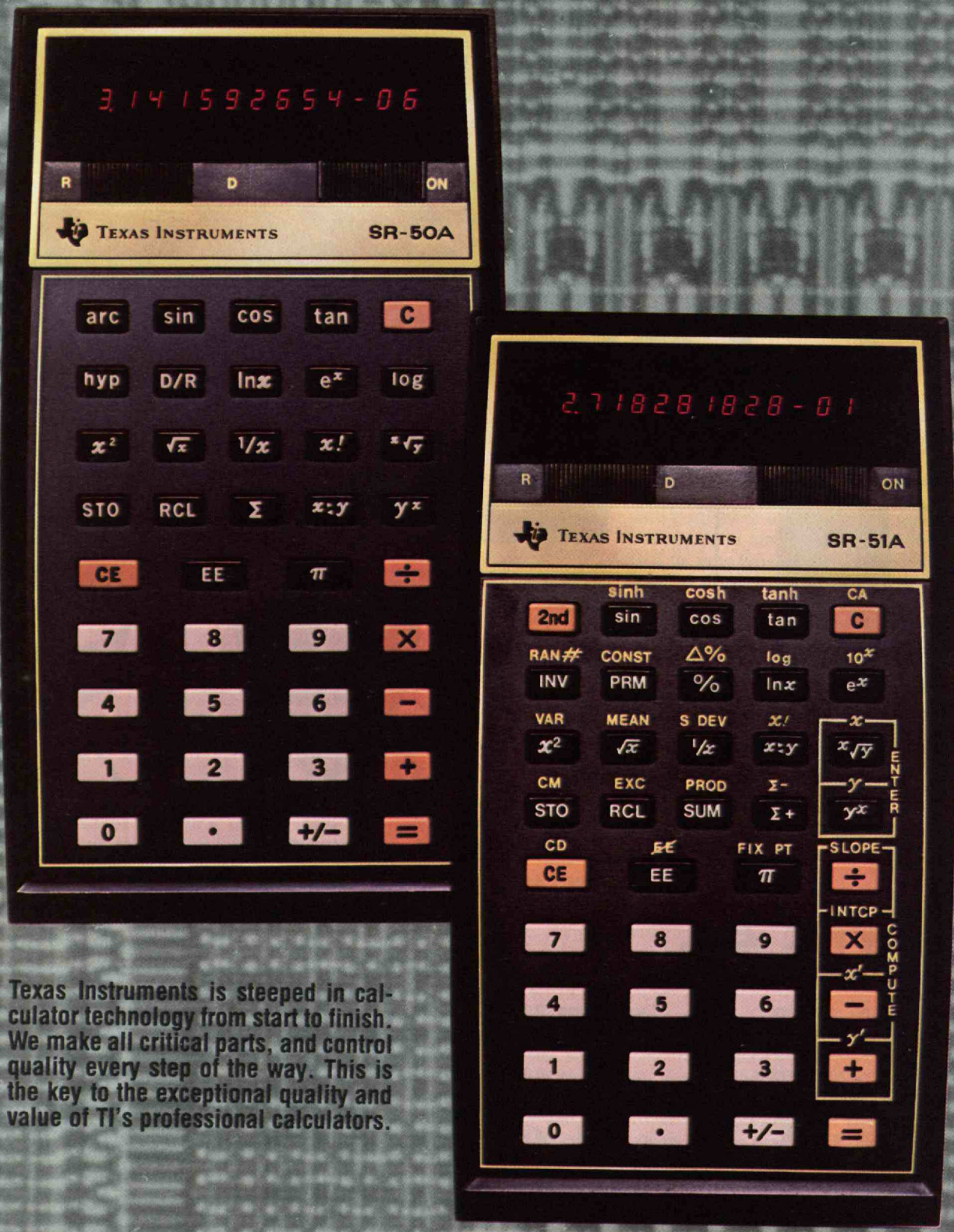

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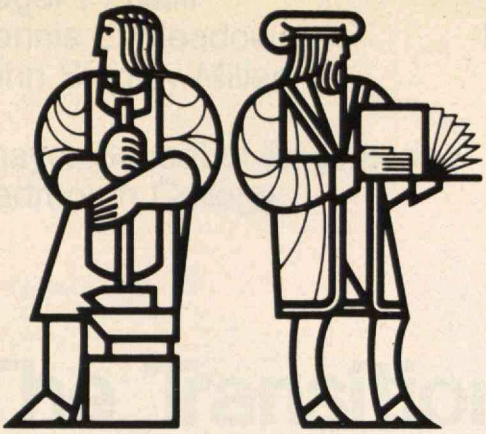

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The MIT/Marine Industry Collegium was formed in 1975 as a working partnership between MIT Sea Grant and U.S. industry. Its purpose is twofold: to identify specific marine business opportunities; and to help companies translate these opportunities into profitable business ventures.

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Coal could play a critical role in bridging the gap between today's dwindling oil and gas supplies and the energy sources of the future. A computer model shows how.

A "continuous-miner" bites into a coal seam, chewing out as much as twelve tons of coal per minute. In one continuous motion, the coal passes from the front of the machine to the rear, where it flows into shuttle cars or a conveyor belt. Such improved mining technology has created an enormous increase in coal-mine productivity over the last two decades.

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The Transition to Coal

Most attention currently focused on energy is directed toward short-term aspects of the U.S. "energy crisis." We hear almost daily about changing air-quality standards for 1976, preventing a potential mining strike, or reducing foreign oil prices and "recycling" the enormous cash reserves of the Arab oil cartel. While such problems are significant, it would be dangerous to approach them without first identifying a long-term energy strategy, just as it would be dangerous to steer an oil tanker while looking only 50 feet ahead.

The basic energy problem facing the U.S. and other industrialized nations is not to secure independence from foreign energy suppliers. It is to negotiate an orderly transition from primary reliance on fossil oil and gas resources to energy sources not tied to finite fuel reserves. Even the federal Project Independence Blueprint does not extend its planning horizon far enough to encompass the full extent of that transition, which, due to the delays in developing long-term energy alternatives, may be expected to last at least through the period 2000 to 2050.

A Massive Energy Transition

Oil and gas currently provide about 75 per cent of U.S. energy. But domestic production of these two fuels has been declining since 1970, and there are no prospects for production rates significantly above today's. Natural gas production, which now supplies 30 per cent of U.S. energy consumption, will probably fall to approximately half the current rate by 1990 according to our analysis, whether or not gas prices are deregulated. The recent reduction in U.S. Geological Survey estimates of oil and gas resources has led the Energy Research and Development Administration (E.R.D.A.) to conclude that current production rates will be "difficult to maintain" despite the expected contribution from offshore and Alaskan deposits.

Ultimate energy sources such as nuclear fusion, solar, wind, ocean thermal gradient, bioconversion, and geothermal are the most desirable alternatives to oil and gas, and they should be developed with maximum speed. But they probably cannot be expected to provide more than 10 to 20 per cent of the nation's energy demand by the year 2000. Previous transitions from wood to coal, and from coal to oil and gas, have taken 60 years or more. There is no reason to believe that the major social and physical adjustments to new energy sources are becoming easier as the society becomes more complex. Thus, the massive changes implied in a nationwide transition to ultimate sources may not permit them to carry the country's energy burden much before 2050.

The extent of the problem posed by the expected decrease in domestic oil and gas production, combined with a slow increase in production from ultimate sources, depends on future energy demand. U.S. energy consumption has grown an average of 3 per cent annually over the past 70 years, and 3.5 per cent over the past 25 years. Clearly any reduction in the historical rate of demand growth would help solve U.S. energy problems. Yet even the "zero growth" scenario of the recently completed Ford Foundation Energy Policy Project assumed that consumption would grow to levels one third above those of today before it stabilized. Under the most optimistic circumstances, the 1975 E.R.D.A. National Energy Plan, released in June, still projects at least a doubling of energy consumption by the year 2000.

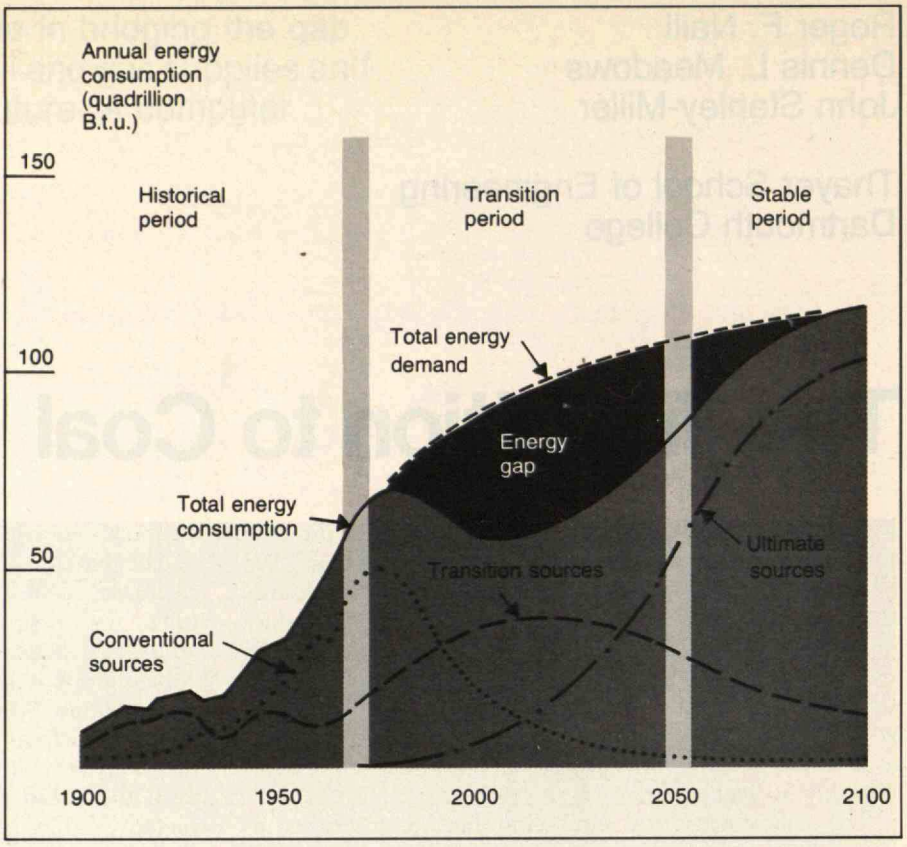
Continued demand growth, decreasing oil and gas production, and long delays in the implementation of ultimate sources raise the possibility of a significant "energy gap" between the energy demanded at prevailing prices and the energy available from domestic sources. The result could be the scenario depicted on page 20.

Three Stages of Energy Growth

The scenario consists of three phases: a *growth* period lasting from 1900 to 1970; a *transition* period from 1970 to around 2050; and a *stable* period continuing more or less indefinitely. During the growth period, energy demand was satisfied by low-cost conventional sources — oil, gas, coal, and hydropower. Cheap, convenient, plentiful oil and gas displaced their chief competitor, coal, and grew from negligible amounts to 80 per cent of the total energy supply by 1970. Inexpensive energy stimulated a high rate of growth in energy consumption, accompanied by a rapid rise in the material standard of living.

During the stable period, most energy could come from nondepletable and relatively pollution-free ultimate energy sources. Conventional oil and gas would likely satisfy only a tiny fraction of energy demand — being used primarily as chemical feedstocks. While ultimate energy sources do not depend upon depletable fuel supplies, their growth is subject to many other constraints, such as capital, institutional, and environmental problems. Thus it is reasonable to expect that the country's energy production will ultimately stabilize.

In our scenario, the transition period presents the greatest difficulties in balancing total U.S. energy supply and demand. Only two domestic fuels have the potential



A possible scenario for U.S. energy: poorly managed transition to ultimate energy sources. The evolution of the U.S. energy system will likely consist of three phases: a *growth* period with major dependence on conventional sources consisting of coal, domestic oil, gas and hydropower; a *transition* period, with major shifts to dependence on oil and gas imports, nuclear power and coal; and a period of *stable* demand, with primary dependence on ultimate sources such as solar power, fusion, bioconversion, and geothermal energy. Without careful planning of transition sources, the U.S. could suffer a serious energy gap during the transition period.

to be important transition energy sources: uranium and coal. But problems associated with capital, labor, and technical requirements and ecological and social impacts could prevent both coal and nuclear power sources from expanding fast enough to offset the decline in oil and gas production. The extreme inelasticity of energy demand (estimated as low as -.1) indicates that rising prices alone cannot constrain energy demand in the face of lagging supply. In the scenario rationing (either intentional or unintentional) or importing energy — along with high prices — serves to balance supply and demand during the transition period. The net consequences could be several decades of high imports, inflation, rising prices, increasing government intervention in both supply and demand decisions, supply interruptions, and stagnation or decline in the material standard of living. Such an unsatisfactory transition phase, while certainly not inevitable, is entirely plausible and may even be the outcome implicit in current policies.

Bridging the Energy Gap

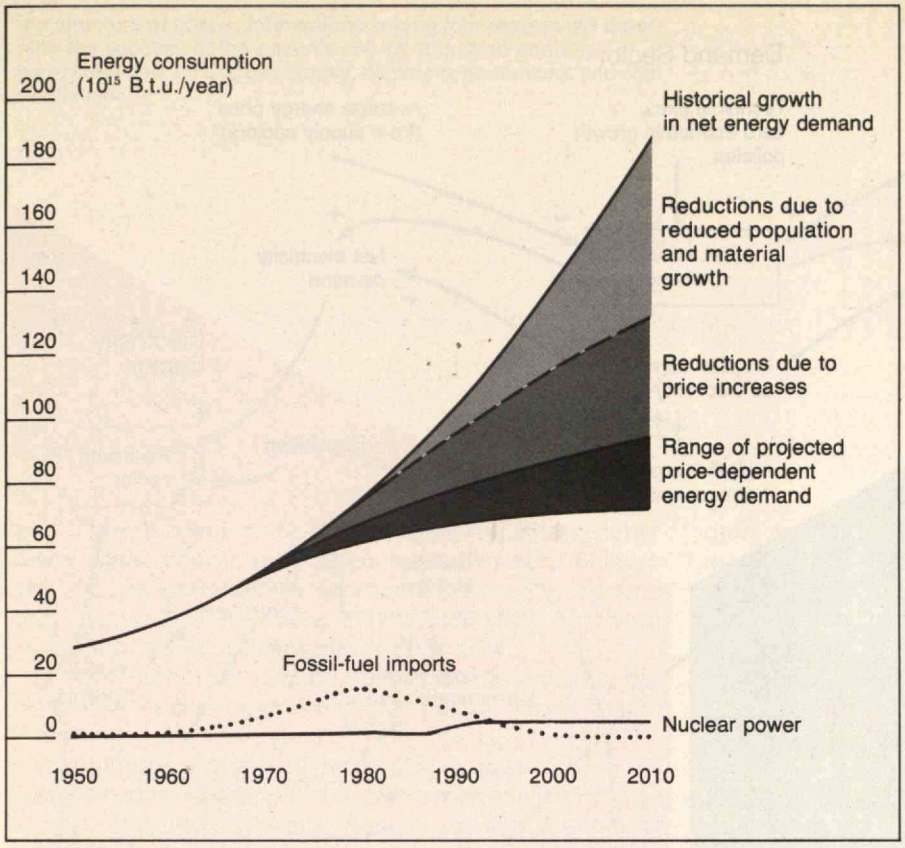
However, an energy gap need not occur at all if we make an effort to bring transition energy sources into use more rapidly. This effort requires planning well in advance of the need for the transition source because of the long implementation delays. First, of course, we must select the transition source. Until the 1973 oil embargo, national energy policy implicitly assumed that fuel imports would be the transition energy source, requiring only more ports, tankers, pipelines, and refining capacity. For example, a 1972 Department of the Interior study projected that oil and gas imports would exceed 28 million barrels per day by the year 2000, or four times the 1973 import level of 6.6 million barrels per day. Now that the negative financial and political consequences of increased imports are more obvious, policymakers are emphasizing increasing use of domestic transition energy sources.

The development of nuclear energy has been promoted by effective and powerful institutions capable of providing the technology and administration to enlarge nuclear capacity greatly by the year 2000. Indeed, nuclear power still remains the largest item in the nation's federal energy research budget. However, there is now substantial and legitimate concern over the reliability of nuclear reactors and the long-term environmental and social implications of widespread handling of their long-lived, extremely toxic fuels and waste products. Those doubts, coupled with lengthening reactor construction delays and the capital shortage confronting the utility industry, have brought about more conservative forecasts of the role of nuclear sources during the transition. The E.R.D.A. "National Plan" projects that fission power may grow from 1.2 per cent of total energy consumption in 1973 to a maximum of 30 per cent by 2000. But even that level of dependence on nuclear power may ultimately prove socially or economically unacceptable. To provide an alternative to accelerated nuclear development we have been working during the past three years, supported by the National Science Foundation, to design a technically feasible, socially and environmentally acceptable transition strategy based principally on coal.

Analyzing Coal Supply and Demand

To design an energy transition strategy based on coal, the Dartmouth Project on the Dynamics of Long-Term Resource Availability has constructed COAL-1, a system dynamics computer simulation model of coal supply and demand (*see page 22*). The model is divided into four sectors: energy demand, oil and gas supply, electricity generation, and coal production.

Net energy demand is the demand for energy from the final consuming sectors — industrial, transportation, and



The assumptions behind the initial run of computer model COAL-1 are that growth in net energy demand will be reduced by lowered population and economic growth, by technological changes that increase end-use efficiencies, and by increases in price. Nuclear power is assumed to grow slowly, and fossil fuel imports will be ended by the year 2000.

household and commercial — and consists of direct fuel use plus purchased electricity. Net energy demand grows as GNP increases, but its growth slows as energy prices rise. The percentage contribution of the three sector outputs that satisfy net energy demand — direct use of oil and gas, electricity, and direct use of coal — can shift over time as a function of relative prices and convenience. For instance, the U.S. economy has experienced a general shift in demand away from direct coal use and a strong shift toward the use of electricity.

The direct use of oil and gas currently satisfies by far the largest fraction of net energy demand — over 80 per cent in 1973. The total demand for oil and gas can be satisfied domestically from only two sources: conventional oil and gas wells, or conversion of coal and oil shale to synthetic fuels.

Electricity satisfied only about 11 per cent of net energy demand in 1973. Yet U.S. electricity generation has grown at over 7 per cent per year for the past 25 years, and is projected to increase its market share to at least 25 per cent of net demand by the year 2000. Hydropower, nuclear power, and fossil fuel conversion will produce most of the electricity generated during the transition period. But hydropower development has nearly reached saturation and therefore cannot contribute significantly to future electricity expansion. Nuclear power generation currently accounts for 5 per cent of electricity generation. Even under the more optimistic E.R.D.A. projections of future growth in nuclear generation capacity, the bulk of electricity produced during the transition period must come from fossil fuel-conversion.

Direct burning of coal satisfied approximately 17 per cent of U.S. net energy demand in 1973, a significant decline from the 36 per cent coal provided in 1950. Potential direct uses of coal appear limited to steelmaking or industrial boiler fuels. The greatest future stimulus to increased coal use should come from synthetic oil and gas plants and coal-fired electric utilities.

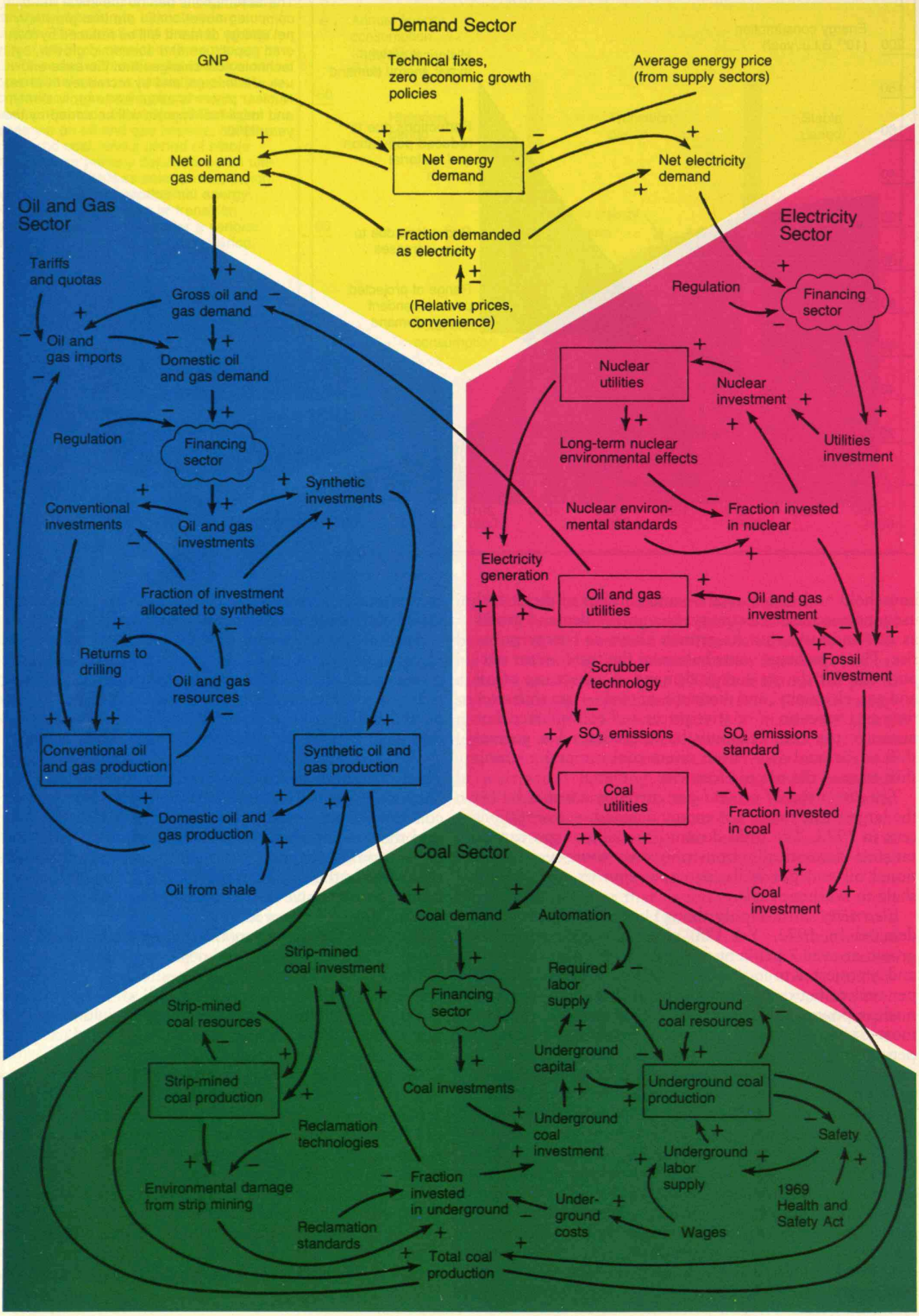
As shown by the structure of COAL-1, developments in energy demand, the oil and gas industries, and the electric power industry are all capable of contributing to future coal demand. But problems associated with both the production and use of coal could diminish its role as a transition fuel.

The Constraints on Coal Demand

During the transition period the combined demand for coal from the synthetic fuel sector and utility sector could lead the coal industry out of its long history of stagnant production into a period of rapid growth, during which coal assumes the dominant role in the U.S. energy supply. But before a massive shift to coal is possible, current constraints must be removed.

One major constraint to U.S. use of coal is the anticipated delay in developing and deploying synthetic oil and gas production facilities. As domestic petroleum depletion forces prices up, investment will shift to synthetic production. At the present rate of increase in domestic oil prices, major investment shifts will likely take place in the next decade.

But even when investment in synthetic fuels finally begins in earnest, there can still be long delays before the fuels are produced commercially. From two to eight years of additional research will be needed before present pilot plants can be scaled up to reliable full-scale production facilities. And construction of the first commercial plants may take an additional five to six years after a successful demonstration plant is built. The need for massive capital investment can cause further delays. If these delays are encountered only after synthetic fuels become price competitive, synthetics may not contribute significantly to U.S. energy supplies — or coal demand — until 1990 or


Demand Sector
GNP
Technical fixes, zero economic growth policies
Average energy price (from supply sectors)
Net energy demand
Net oil and gas demand
Net electricity demand
Fraction demanded as electricity
(Relative prices, convenience)
Oil and Gas Sector
Tariffs and quotas
Gross oil and gas demand
Oil and gas imports
Domestic oil and gas demand
Regulation
Financing sector
Synthetic investments
Conventional investments
Oil and gas investments
Fraction of investment allocated to synthetics
Returns to drilling
Oil and gas resources
Conventional oil and gas production
Synthetic oil and gas production
Domestic oil and gas production
Oil from shale
Electricity Sector
Regulation
Financing sector
Nuclear utilities
Nuclear investment
Long-term nuclear environmental effects
Utilities investment
Nuclear environmental standards
Fraction invested in nuclear
Electricity generation
Oil and gas utilities
Oil and gas investment
Fossil investment
Scrubber technology
SO_2 emissions
SO_2 emissions standard
Coal utilities
Fraction invested in coal
Coal investment
Coal Sector
Coal demand
Automation
Strip-mined coal investment
Financing sector
Required labor supply
Underground coal resources
Strip-mined coal resources
Underground capital
Strip-mined coal production
Coal investments
Underground coal production
Reclamation technologies
Underground coal investment
Safety
Underground labor supply
Environmental damage from strip mining
Fraction invested in underground
Under-ground costs
1969 Health and Safety Act
Reclamation standards
Wages
Total coal production

The structure of COAL-1. Interactions among four sectors will determine the success of the nation's energy transition strategy — energy demand, oil and gas supply, electricity generation, and coal production.

later. Thus, if coal is to be an important transition energy source, these delays must be circumvented with policies such as price guarantees or accelerated research programs that encourage developing and constructing synthetic energy sources in anticipation of their need.

Environmental air quality standards that restrict the use of coal in electric power plants pose a second major constraint to the coal industry. Sulfur dioxide (SO_2) emission standards established in the 1960s have shifted investment originally intended for new coal-fired utilities to oil, gas, and nuclear plants. As a result, coal's share of total U.S. electricity capacity has declined since 1965. Two types of policies may reduce the environmental constraints on the construction of new coal-fired utilities:

— Technological policies that reduce SO_2 emissions, such as the use of low-sulfur coal, solvent refining, or stack-gas cleanup devices

— Legislative policies that relax emissions standards — for example, intermittent controls, abandoning the "no-degradation" interpretation of the Clean Air Act, or postponing the deadline for compliance with the Clean Air Act.

Since the latter course helps the energy problems but exacerbates the pollution problem, the former approach is clearly preferable. Overcoming the second constraint on coal demand therefore also requires foresight in investment and research, in this case to furnish or subsidize clean methods of burning coal.

The Constraints on Coal Supply

Even if the constraints on coal demand from synthetic industry delays and air quality standards can be avoided, existing coal supply constraints may be severe enough to limit future growth in coal production. The movement of the coal industry into a major role during the energy transition period is contingent upon production of large amounts of strip-mined and underground coal. Yet both could be in short supply over the next 30 years because of two major constraints — environmental standards for surface mines and labor difficulties.

Although coal production in the United States has remained relatively constant from 1910 to the present, production of coal from surface mines has come to provide almost 50 per cent of the total in 1972. Much of this surface-mined coal — 45 per cent — is mined in the East, yet western surface coal production has grown rapidly from near-negligible amounts in the early 1960s to 18 per cent of all surface-mined coal production in 1972. This shift is likely to continue, since eastern deep-mines require five times more labor per B.t.u. and three times more capital per B.t.u. than western surface mines.

Both strip-mined and underground coal production have negative environmental impacts which could constrain their growth during the transition period. The environmental damage associated with eastern strip mining has been significant, due to the difficulty of rehabilitating the rough eastern terrain and the lack of stringent regulations. Rehabilitating the western strip-mined coal lands depends largely on the average rainfall of the mined area. According to a Ford Energy Policy Project report, only those areas with ten inches or more of annual rainfall can usually be rehabilitated. This criterion still permits access to about 80 per cent of western coal reserves, primarily in the northern Great Plains region.

Regional or federal strip mining reclamation and development standards could restrict investment in surface coal mines if the costs of compliance were high. Yet according to most estimates, even the strict federal reclamation standards recently proposed by Congress could be met at reasonable per-B.t.u. costs. More serious than the actual damage to the land may be the social and ecological consequences of rapid coal development. Potential secondary problems for the West concerning excessive water use and rapid influx of labor could be minimized by locating conversion facilities near the demand centers, where there is more water and a greater indigenous labor force.

A Miner Difficulty

The number of coal miners is relatively small and has declined substantially under the dual impacts of improved machinery and the shift to surface-mined coal. Today 150,000 workers mine more coal than was produced by 400,000 workers 25 years ago. However, even assuming continued high levels of labor efficiency, the F.E.A. Project Independence Blueprint in its accelerated energy development scenario projected a tripling of the coal mine labor force by 1990.

Attracting the labor necessary for sharply increased coal production may prove difficult. Forty per cent of the current coal labor force will reach retirement age within ten years. Even more workers may be induced to retire soon by the black lung compensation program which now offers a retired miner afflicted with the disease supplementary annual compensation of $2250-4500 per year.

While wages in the industry have generally been higher than average, coal mining remains the most dangerous

This large-scale synthetic gas plant processes about 75 tons of coal per day to make 1.5 million cubic feet of synthetic gas. The authors recommend that 50 per cent of the nation's oil and gas production investment be diverted to such technology by 1985, to encourage coal production and that federally guaranteed synthetic oil prices be instituted to reduce delays in research. (Photo courtesy of the Institute of Gas Technology)

major occupation in the United States. The historical rate of over 50 non-fatal injuries per million man-hours is up to four times higher than comparable-risk industries such as construction, lumberjacking, or air transportation. There has been a sharp drop, however, in the accident rate since early 1974 — to 25 injuries per million man-hours — as the Coal Mine Health and Safety Act of 1969 has been more strictly enforced.

If the underground coal industry is to attract large numbers of new miners, such safety improvements must be continued and the accident rate must be kept low. Coal mining can be carried out safely, as shown by a number of isolated cases. For instance, coal production by U.S. Steel Mines had an associated accident rate of only 2.7 injuries per million man-hours from 1968 to 1971.

COAL-1 and Coal Policy

As the structure of COAL-1 shows, the many constraints on coal demand and supply are parts of an integrated system — any policy changes in energy demand, synthetics, power plant emission standards, strip-mining legislation, or health and safety standards will ultimately affect the evolution of the entire energy system. COAL-1 can keep track of these complex interactions so that the effects of coal-related energy policies can be assessed throughout the total system over time.

Before the model can be used to examine specific coal-related policies, we must first specify a combination of energy demand, imports, and nuclear power. The balance of emphasis on conservation, self-sufficiency, and nuclear power is a political decision, and we can test any desired combination of these three policies. The model can be used only to reveal the general dynamic outcome of any given choice — it cannot predict which combination will actually be chosen.

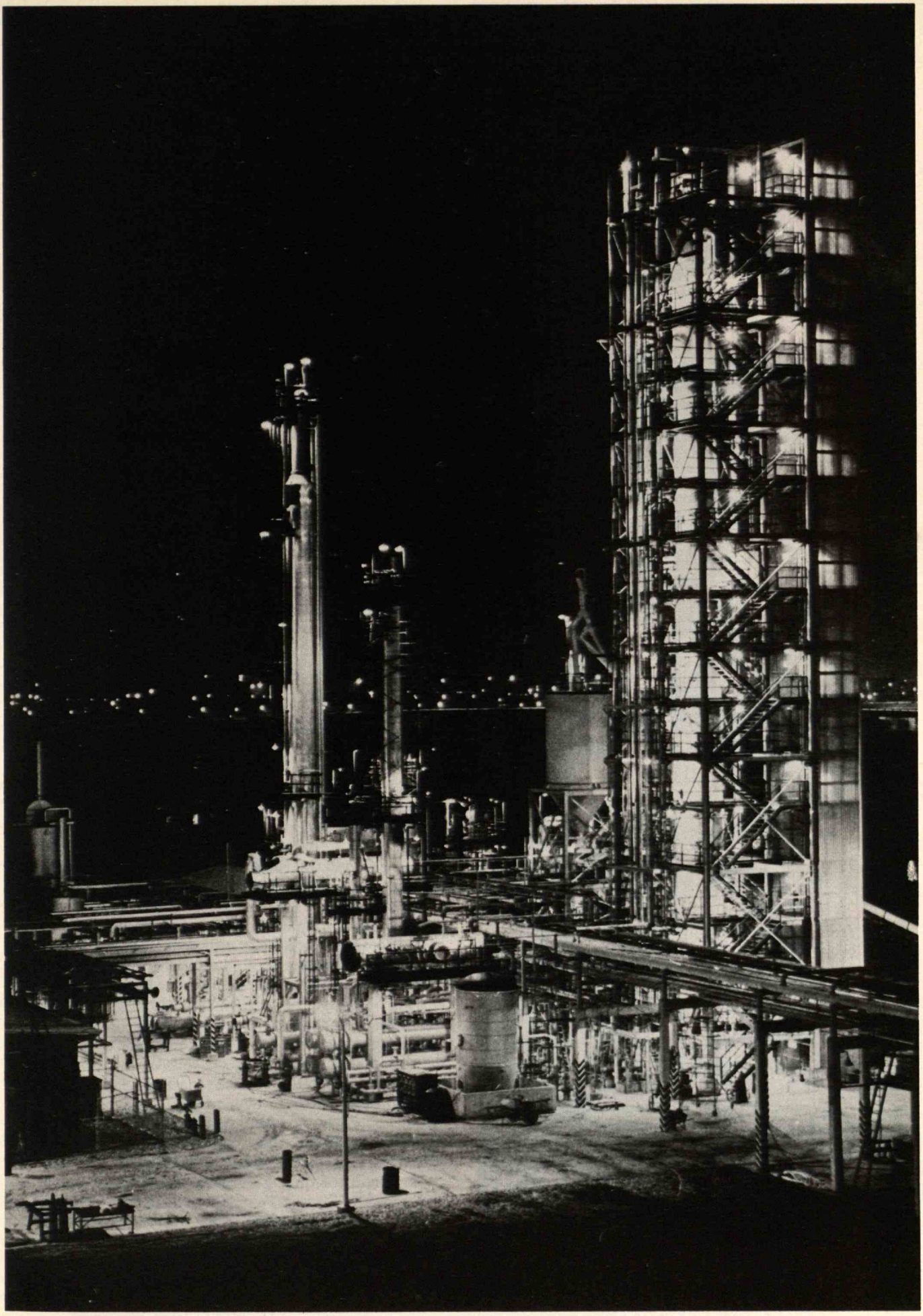
One possible combination of energy conservation, imports, and nuclear power over the next 35 years is shown on page 21. The behavior of demand shown in the figure is adapted from the Ford Foundation "Zero Energy Growth" scenario. Historical growth rates of energy demand are assumed to decrease because of lowered rates of population and material growth, and also because of price increases that cause consumers and producers to increase the efficiency of their energy use. The projection on page 21 also assumes that imports will gradually be brought to zero by the beginning of the next century, consistent with the more optimistic of the E.R.D.A. projections. Nuclear power is projected to level off at 170 gigawatts by 1990 (4.6 times current capacity) because of both environmental and economic constraints on nuclear growth.

With these assumptions as inputs to COAL-1, we arrive at the projection of the future behavior of the U.S. energy system shown at the top of page 27. The model output reproduces the major trends in energy consumption observed in the United States during the historical period: coal production remains stable at about 15 quadrillion B.t.u.s a year from 1950 to 1970, while oil and gas consumption rises to provide about 75 per cent of the 70 quadrillion B.t.u.s of gross energy consumed in 1970. The average energy price rises slightly over the historical period, primarily as a result of a shift to electricity, a more expensive form of energy.

Under these assumptions, energy demand continues to rise well into the transition period, though at a much slower rate than during the historical period. As domestic oil and gas resources are depleted, the production from domestic wells — including those in Alaska and offshore — peaks around 1980 and declines thereafter. The constraints on coal supply and demand prevent coal production from rising fast enough to close the gap between growing energy demand and declining oil and gas production. Nor is the gap eliminated if we adopt the Atomic Energy Commission's optimistic 1972 projections of 10 per cent annual growth in nuclear power output. Our further experiments with COAL-1 showed that even with an accelerated nuclear program, domestic energy production still does not meet energy demands during the transition period. The higher nuclear power capacity does reduce future electricity shortages over the long term, but electricity constitutes only 40 per cent of net energy demands by the year 2010. Major shortages of the remaining demanded energy sources — the fossil fuels — appear between 1985 and 2010.

In periods of shortage, energy producers and distributors will raise energy prices. Although COAL-1 incorporates this effect, the shortages shown in the reference projection (*see top chart, page 27*) persist, for two reasons. First, the rigid schedule of oil and gas imports assumed as an input to the model — similar to an oil import quota policy — prevents imports from filling the gap. However, with the severe shortages shown in the reference projection, an oil import quota system would most likely be relaxed. If the gap shown is filled with imports, the nation would eventually depend on foreign sources for over 80 per cent of its oil and gas supply in the year 2000.

A second reason for persistent shortages in the refer-



Huge strip mining machines, such as Hanna Coal Company's "Gem of Egypt," shown here, help account for the fact that Western strip mines require one-fifth as much labor per B.t.u. than Eastern deep mines. The 7,000-ton shovel is higher than a 12-story building, and can pick up 200 tons of rock and clay at a single pass. (Photo courtesy of Hanna Coal Co.)

ence projection stems from the short-run inelasticity of coal supply and demand. Delays in the development of synthetic technologies and emission control equipment retard growth in coal demand until after the year 1990. Thereafter, so many synthetic plants and coal-fired utilities are brought into operation that these users of coal are faced with a coal supply shortage. Restrictions on the strip mining of coal force investments in underground coal mining to rise rapidly after 1990. The constraints on labor force expansion due to the industry's poor safety record cause total coal production to lag behind demand.

Filling the energy gap with increased amounts of foreign oil imports is a poor policy alternative — a last-minute solution to a mismanaged energy transition period. As a second alternative, policymakers could release the constraints on coal supply and demand, thereby allowing coal to become the major transition energy source.

Reducing the Constraints on Coal

To ease the constraints on coal, the following set of policies were tested in COAL-1:

— *Oil and gas.* A large fraction of total oil and gas investments is diverted to development and construction of synthetic fuel facilities in anticipation of the continued rise in domestic oil and gas costs. Fifty per cent of the industry's total investment in oil and gas production facilities is allocated by 1985 to synthetic development.

— *Electric utilities.* SO_2 emissions are reduced by installing and retrofitting stack gas devices as they prove reliable. We assume a 90 per cent reduction in the average emissions per power plant by the year 1980 at an additional capital cost of $50 per kilowatt of capacity.

— *Strip mining.* Legislation on federal strip-mining standards is enacted to allow mining in areas where the reclamation potential is adequate, and strict guidelines on the reclamation procedures are followed.

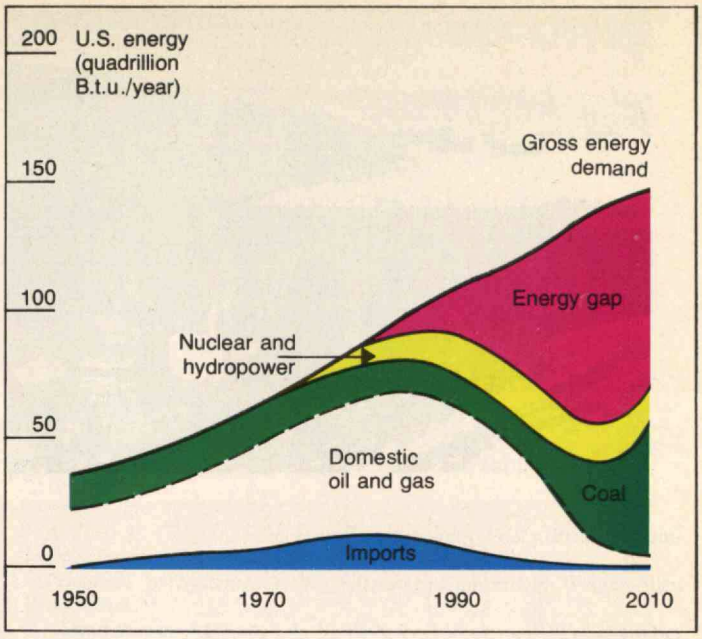
— *Labor.* The relative attractiveness of coal mining as an occupation is enhanced by increasing wages and reducing the accident rate. Accidents decline in response to increasing investments in mine safety capital and stringent adherence to accepted safety procedures.

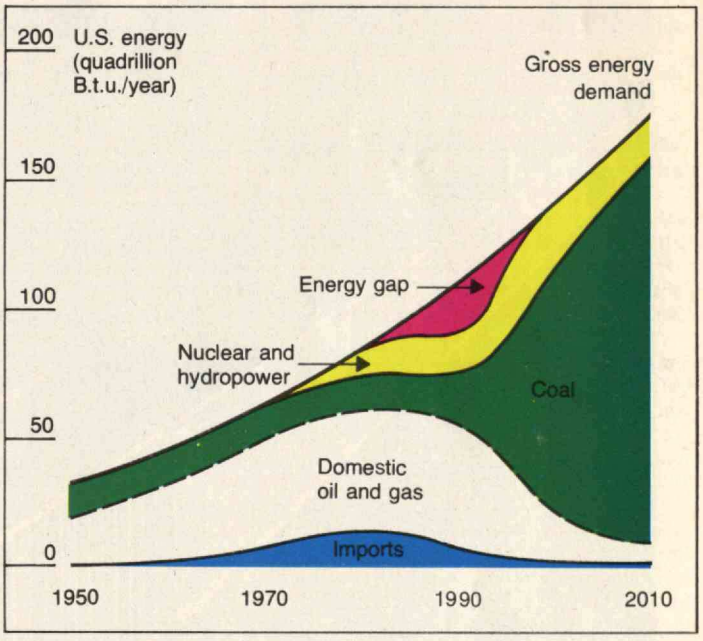
The results of these additional assumptions are shown in the middle figure on page 27. The demand for coal increases much sooner than in the previous run. Increased strip mining plus greater availability of coal labor allows coal production to rise much more quickly than before. As a result, the production of coal and coal-based products takes over most of the long-term energy supply

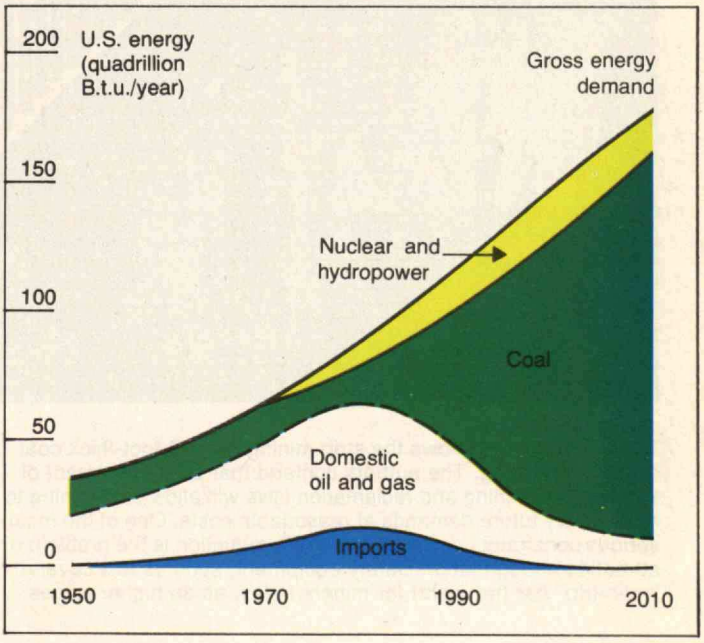
Top:
Given the assumptions shown on page 21 the combined energy from nuclear power, imports and coal could be insufficient to close the energy gap. Other simulation runs show that even an accelerated nuclear program would not be enough to close the gap. (Note that gross energy demands are considerably higher than the final or net energy demands due to energy conversion losses.)

Center:
The energy gap could be reduced if coal production were encouraged by investing heavily in synthetic oil and gas facilities, reducing coal power plant emissions, legislating federal strip-mining regulations, and increasing wages and safety for coal miners. Still the rapid "elbow-shaped" increase in coal demand produces a short-term energy gap.

Bottom:
The short-term gap caused by the rapid increase in coal demand can be relieved by reducing delays in synthetic oil and gas development, temporarily relaxing SO_2 standards for power plant emissions, and banning construction of oil- and gas-fired power plants. Price guarantees, direct subsidies or accelerated exports would also be used to encourage coal production expansion smoothly after 1975.







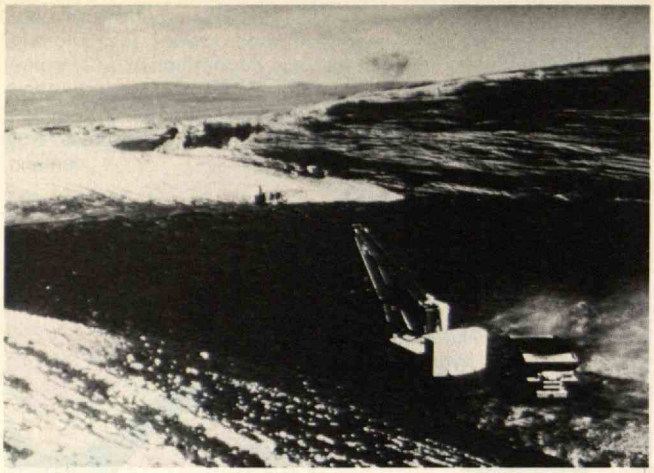
burden as domestic oil and gas production decreases. However, while the long-term transition problem is solved, a short-term coal shortage between 1985 and 1995 persists. The coal industry faces a short-term production start-up problem as coal demand moves from stagnation to rapid growth in the late 1980s. This "elbow-shaped" demand for coal is caused by a rapid rise in the demand for coal from synthetic oil and gas production plants coming on line after 1985, coincident with a rapid increase in coal demand from electric utilities after 1985. The release of the SO_2 constraint after implementation of the stack gas policy in 1980 increases investment in new coal-fired utilities, which begin to come on line rapidly after 1985.

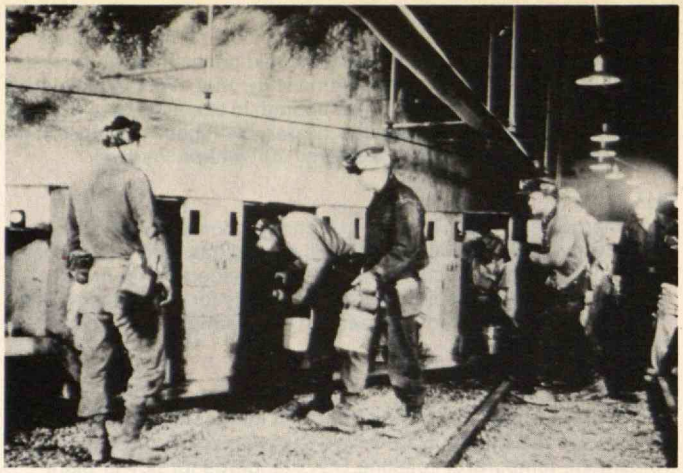
Straightening Out the Elbow

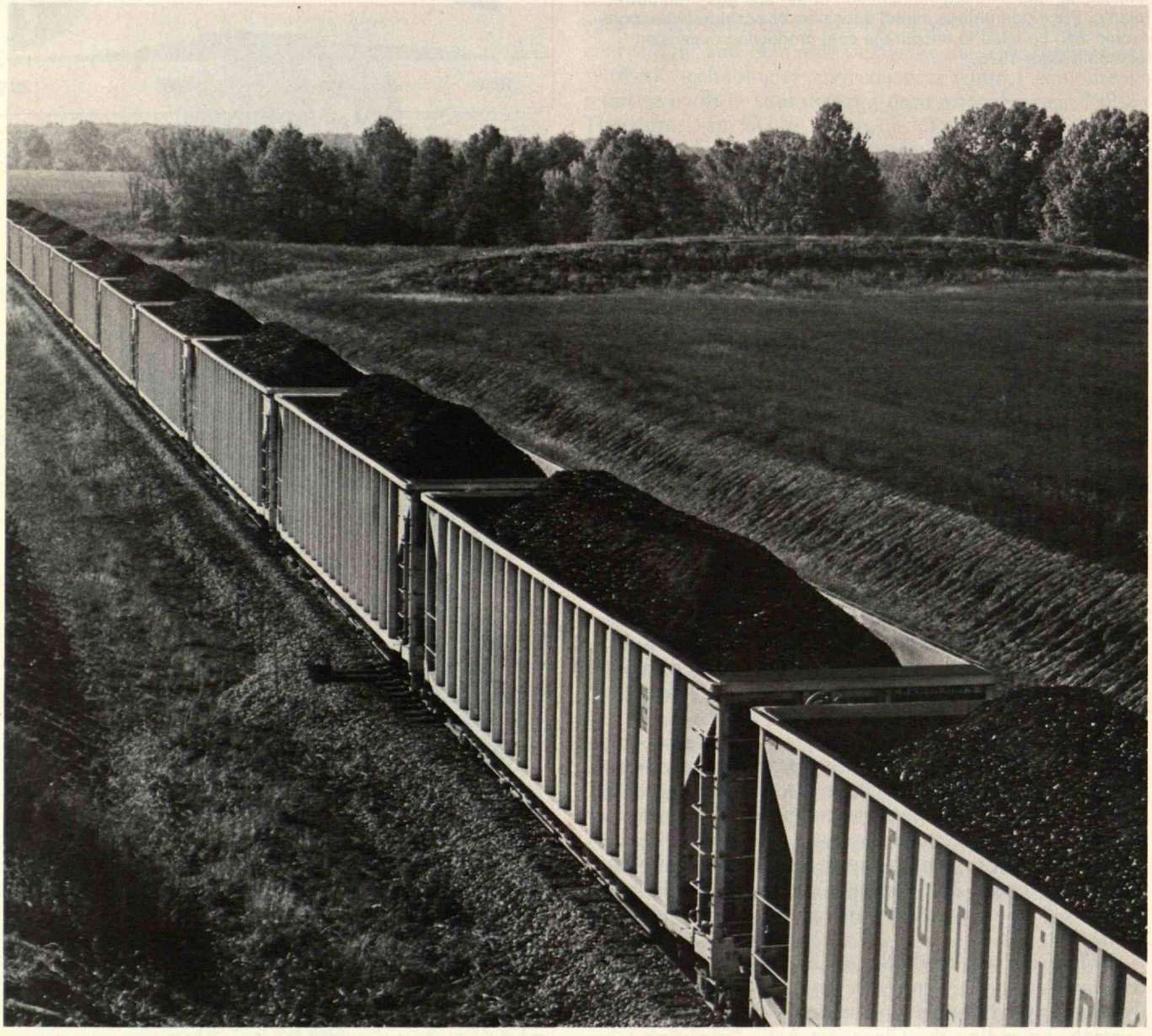
To alleviate the short-term coal start-up problem, the nation must begin to encourage coal demand *before 1985,* thereby expanding coal production capacity over a longer period. Although a number of policies might be equally effective, we recommend the following supplemental policies:

— *Synthetics.* Increase short-term coal demand from synthetics by reducing delays in synthetic research and development. The delays might be shortened either by an intense research and development program to develop high-B.t.u. synthetic technologies or by an early commitment to the more proven low-B.t.u. technologies. One possible incentive for synthetic programs would be a federally-guaranteed, long-term synthetic product price floor.

— *Utilities.* Two methods of increasing the use of coal-fired utilities are currently being debated: temporarily relaxing environmental standards — e.g., intermittent controls, amending the Clean Air Act — or using low-sulfur coal. Because the supply of low-sulfur coal is limited in the short term, we suggest a policy that relaxes SO_2 standards for five years only, while initiating a forced stack gas conversion program that will bring all utilities into compliance by 1980. In addition, construction of oil- or gas-fired power plants should be banned from 1975 onward.







The top left photo shows the strip-mining of a 32-foot-thick coal seam in Wyoming. The authors contend that swift enactment of strict federal mining and reclamation laws will allow coal mining to meet heavy future demands at reasonable costs. One of the most serious constraints on increased coal production is the problem of attracting enough labor. Safety equipment, such as this covered "man-trip" car (top right) for miners helps, as do higher wages.

Directly above, loaded cars of a unit train travel from the coal mine to the electric utilities or other large customer. When the train is unloaded, it will speed back to the mine to be refilled and then return once again. Unit trains which carry nothing but coal directly from mine to market have helped lower transportation costs, thus making the delivered coal price a bargain. (Photo courtesy of the National Coal Association)

— *Coal production.* To anticipate the forecasted rise in coal demand, encourage coal companies to expand from 1975 onward, thereby creating an excess of coal production capacity for a few years. Price guarantees, direct subsidies of excess capacity, or an accelerated export program could achieve this expansion.

As our final model run *(bottom chart, page 27)* shows, with these additional short-term policies, coal production keeps pace with the smoothly-rising demand, and long-term energy shortages are avoided. In this scenario, the United States becomes dependent on coal for 80 per cent of its energy in the year 2010. Such dependence would reflect a rather extreme emphasis on coal; certainly large amounts of imports or nuclear power could be substituted for coal-based energy products. The extreme case shown here serves to illustrate the potentially vital role that coal might play in fulfilling future energy needs. The proposed coal program is *not* unique and is meant as an indication of the types of policies necessary for a smooth transition to coal. Our technical reports provide analyses of several different scenarios with varying emphases on policies affecting energy demand and the three transition sources: imports, nuclear power, and coal.

As the energy transition continues, coal demand should level off as the growth in energy demand slows and as the substitution of coal for other forms of energy decreases. Although the accelerated development of coal depletes only 10 per cent of the total U.S. coal resources by the year 2010, coal resources — and especially strip-mineable coal — are nonetheless finite. Their use only buys time until the energy transition is truly completed with a shift to such ultimate sources as solar energy, fusion, or geothermal power in the next century. Just as vital policy changes are required to manage the transition to a coal-based economy, new policies will be necessary to slow the growth in coal production in an orderly fashion, and to make a smooth transition to those sources that can ensure energy supplies for the balance of the 21st century.

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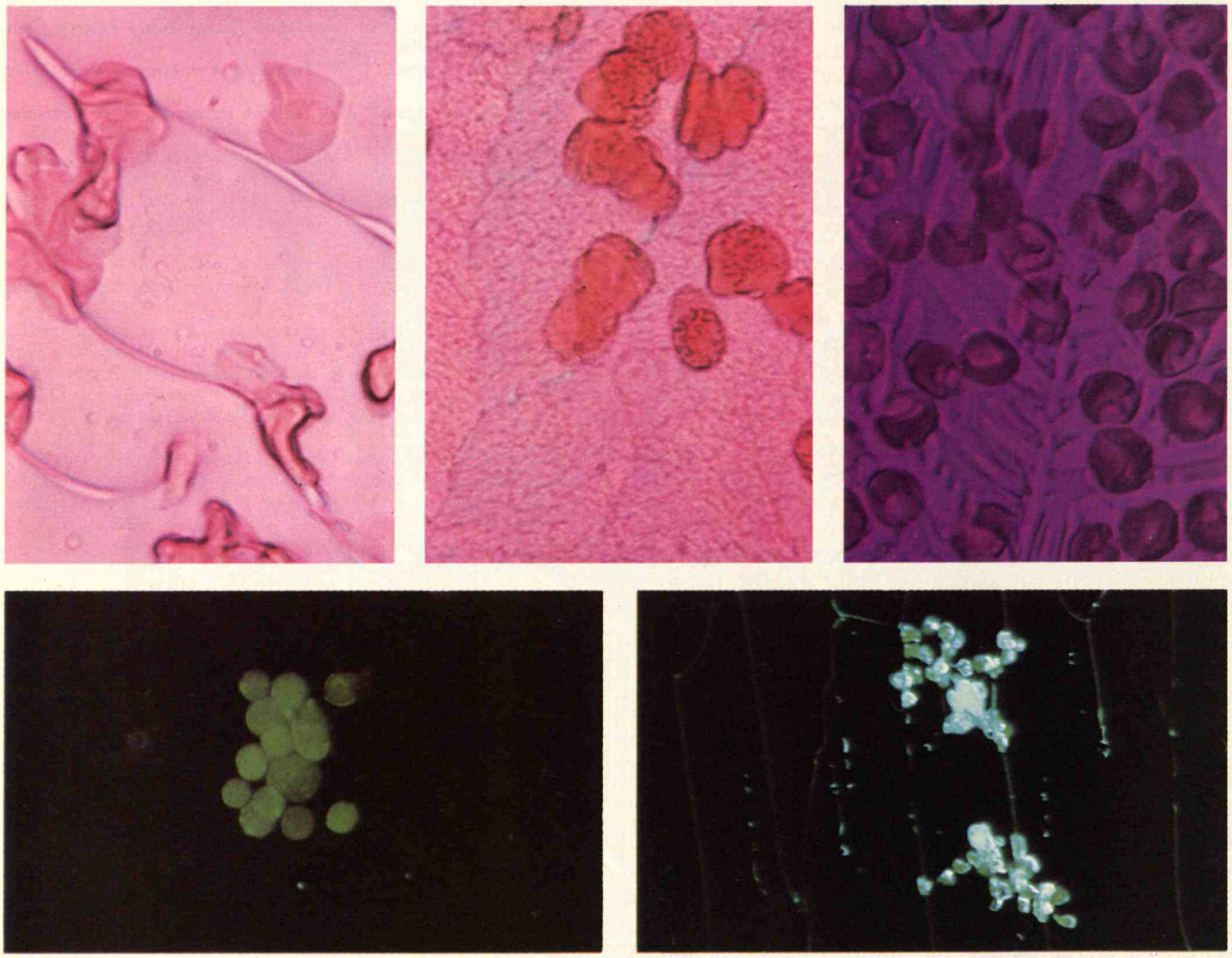
Roger F. Naill is Director of the Project on the Dynamics of Long-Term Resource Availability at Dartmouth's Thayer School of Engineering. He received his M.S.M. from the Sloan School of Management at M.I.T. in 1972 and will complete his Ph.D. from Dartmouth College in the fall of 1975. **Dennis L. Meadows** is an Associate Professor of Engineering and Management at Dartmouth. He is Director of the Thayer School Research Program on Technology and Public Policy. While on the faculty of M.I.T. from 1970-1972, he directed a three-year study of limits to growth that pointed to the impending depletion of domestic oil and gas and lead to his current N.S.F.-sponsored research into the dynamics of long-term coal availability. **John Stanley-Miller,** formerly a Research Associate of the Dartmouth Coal Project, received his Ph.D. in Civil Engineering from M.I.T. in 1974. He is currently on the faculty of the Environmental Engineering Department at the University of Southern California.

Red blood cells, corneas, and spermatozoa are now routinely frozen for storage. Extending this success to other biomaterials may be difficult: several mechanisms appear to cause cell death as the temperature drops.



Top row: The freezing of human red blood cells, photographed under polarized light at a magnification of 630 diameters. The leftmost photograph shows cells that have been frozen slowly. Large ice crystals have formed in the medium in which the cells are suspended; the cells themselves are trapped in the interstices between those crystals. The middle photograph shows rapid freezing. The cells have retained more of their water, and are consequently larger. A granular appearance throughout the field of view is due to the formation of small ice crystals both inside and outside the cells. The rightmost photograph shows cells frozen in a medium containing glycerol, an agent known to afford protection to cells during freezing. Ice forms in treelike patterns outside the cells, and not at all within them.

Bottom row: The freezing of human epithelial (HeLa) cells, photographed under darkfield illumination, in which light plays on the microscope's stage from the side. The magnification is 300 diameters. Cells in the left photograph give off fluorescence due to the presence within them of a fluorescing molecule. The right photograph shows the cells after freezing. Green fluorescence comes from those cells whose membranes have remained intact; while light is diffracted upward into the microscope's optics by intracellular ice crystals. As in the top left photograph, large extracellular ice crystals have formed; their presence is shown here by the diffraction of light at the crystal boundaries and by fluorescent molecules that have leaked from the disrupted cells.

Ernest G. Cravalho
Department of Mechanical Engineering
M.I.T.

The Cryopreservation of Living Cells

The preservation of biological materials in the frozen state is a prospect that has intrigued man for centuries. In 1683, Robert Boyle published what is probably the first written account of low-temperature biological research. Boyle studied the effects of freezing and thawing on various foodstuffs, including meat, eggs, and fruit; and he found that live fish and frogs could survive freezing for short periods provided their bodies were not completely frozen. In the three centuries since his report first appeared, innumerable investigators have tried without success to "unlock the door to eternal life." Naturally, the possibility of such a discovery has given modern science-fiction writers the opportunity to exercise their imaginations to the fullest. There are even accounts in New England folklore of humans preserved in the frozen state. Unfortunately, there is little scientific evidence to suggest that the suspended animation of humans will be anything more than fantasy in the immediate future. However, there is every reason to believe that serious scientific inquiry into the potential application of low temperatures for the long-term preservation of biomaterials will lead to ultimate success.

The Cooling Velocity

In 1949, Polge, Smith, and Parkes reported the most significant advance in low-temperature biology since Robert Boyle's early work. They found, quite by chance, that the addition of glycerol to a suspension of spermatozoa prior to freezing produced a dramatic increase in the post-thaw viability of the cells. The lack of a satisfactory explanation for this protective action did not hamper the efforts of a considerable number of scientists to exploit the remarkable discovery. Since 1949, several classes of biomaterials have been successfully preserved on a clinical scale, most notably blood, spermatozoa, cornea and skin. Attempts to extend this preservation to other biomaterials have been less successful; however, the effort has increased our understanding of the effects of freezing and thawing on biomaterials.

In general, two observations can now be made:

— The biochemical and physical processes of life are affected to varying degrees by temperature, but if low temperatures are successful in arresting these processes, then the lower the storage temperature the better. In fact, recent evidence indicates that there is no lower limit to the temperature at which properly prepared biomaterials may be stored.

— For survival after the freeze-thaw cycle, the rate at which temperature changes (the so-called temperature velocity) is probably the most important parameter for biomaterials frozen in the absence of cryoprotective compounds. In particular, the "cooling velocity" — the rate of temperature change after the first appearance of solidification — is probably more important than the temperature velocity during thawing.

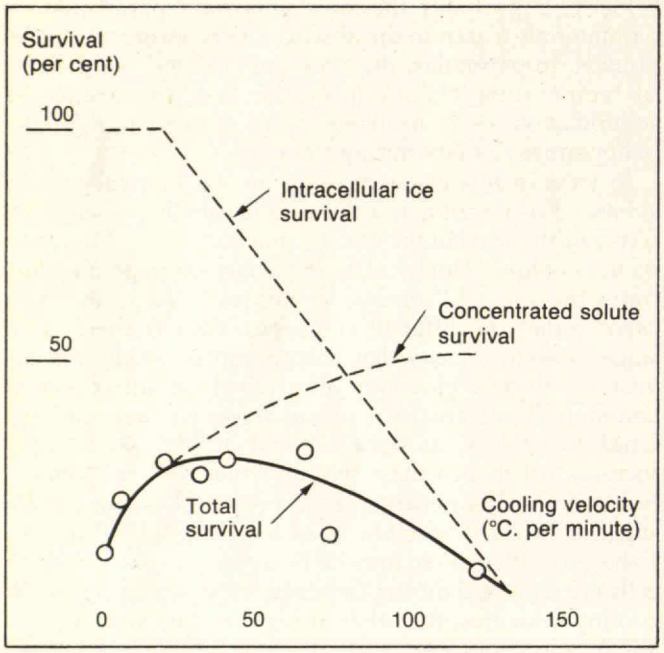
In view of this evidence, data on the survival of cells subjected to freezing and thawing is usually presented in terms of the percentage of cells that survive as a function of the cooling velocity. The left chart on page 34 illustrates the sort of "survival signatures" that result from such studies on different cell types. Clearly there is no single cooling velocity that will guarantee maximum survival for all cells. However, all survival signatures exhibit common characteristics. Survival at low cooling velocities tends to be low, as does survival at high cooling velocities. In between these two extrema, survival tends to be maximal. The net result is an inverted U-shape, which suggested to Dr. Peter Mazur of the Oak Ridge National Laboratory that there may be two mechanisms by which cells are damaged during freezing, one dominating at low cooling velocities, the other at high cooling velocities. In between is a transition region in which both mechanisms are operative, but neither is very strong. Experimental observations support this hypothesis. At low cooling velocities, large ice crystals form outside cells in the extracellular medium, while at high cooling velocities the ice structure tends to be much finer grained and exists both inside and outside the cells.

Cell Death by Freezing

Cells in fluid suspension are frozen by placing the suspension in thermal contact with some sort of refrigeration source. Heat then moves from the cells to the refrigeration source through the suspending medium, and as a result, the temperature outside the cells tends to be lower than the temperature within, regardless of where the cells are located in the temperature field. Eventually ice forms outside the cells and the concentration of extracellular solutes increases, thereby upsetting the chemical equilibrium between the intracellular and extracellular media. The cell attempts to restore this equilibrium by an osmotic outflow of water across the cell membrane. If the cooling velocity is low, and there is sufficient time for this water transport to occur, the volume of the cell decreases while the concentration of intracellular solutes increases.

The specific cause of cell death in this state is not clearly understood, but several possibilities suggest themselves. For example, it is possible that the high concentra-

Data on the survival of HeLa S-3 cells is used to test the two-mechanism theory of cell damage during freezing. The survival signature is determined by a technique in which a fluorescent molecule is found within a cell only if that cell's membrane is intact. The presence of ice crystals within cells is then detected by examining light-scattering under so-called dark-field illumination. Such ice is presumed to cause cell death. The other deaths may result from a lethal concentration of intracellular solutes.



tion of solutes disrupts the cell membrane. It has also been suggested that the cell membrane is a collection of molecules maintained in a stable configuration through their interaction with liquid water. As water is removed from solution by freezing, the membrane becomes unstable and is disrupted. In all probability, membrane injury during slow cooling results from a combination of these processes as well as others that occur during freezing.

At higher cooling velocities, the limited permeability of the cell membrane to water hampers the cell in its attempt to maintain chemical equilibrium. In fact, since the membrane permeability to water decreases with the temperature in an exponential fashion, the membrane "turns off" the flow of water. Thus the intracellular medium comes to have a lower concentration of solutes than the extracellular medium, a condition that favors the formation of ice within the cell. By some mechanism, at the present time unclear, the presence of this intracellular ice results in cell damage. There is some evidence that indicates the involvement of the membrane, but details are lacking.

These two mechanisms, known as the solute concentration mechanism and the intracellular freezing mechanism, do not operate independently, as the preceding description might imply. The right chart on page 34 illustrates most simply how they act in concert. At low cooling velocities, the likelihood of intracellular ice formation is low since the mass transfer across the cell membrane is able to maintain equilibrium. However, the attendant dehydration of the cell results in lethal concentrations of solutes. At high cooling velocities, water is trapped inside the cell because of the formation of intracellular ice. The solute is immobilized in the spaces between ice crystals, so the effects of solute concentration are minimal. However, the intracellular ice exerts its destructive influence. Between these two extremes we have the combined effects shown in the illustration.

The Cryomicroscope

Recent experiments in our laboratory have provided strong support for the two-mechanism hypothesis. We have developed an apparatus, the cryomicroscope, that permits us to study the dynamics of the freezing process. Basically the apparatus consists of a small copper block through which refrigerant (saturated nitrogen vapor at one atmosphere pressure) flows. The block is fitted with a quartz window positioned so that the microscope illumination passes at right angles to the refrigerant flow. An electrically conductive coating is deposited on the underside of the quartz window. With the specimen placed on the top surface of the quartz, electrical current is passed through the conductive coating. By modulating the current, it is possible to modulate the cooling effect of the refrigerant stream and thereby control the temperature of the specimen. A programmable analog computer system permits us to alter the specimen temperature automatically at any desired constant rate between 0.1°C and 7,000°C per minute.

Using the cryomicroscope and a fluorescent dye technique, we have been able to determine the survival signature for HeLa cells of the S-3 strain — cultured human epithelial cells. In the fluorescent dye viability test, a nonfluorescing molecule is present in the medium in which the cells are suspended. This molecule is transported across the cell membrane into the interior of the cell, where it is converted to a fluorogenic molecule called fluorescein, which is trapped within the cell unless the cell membrane is disrupted. If the cell is now irradiated with light at a wavelength of 4,800 Ångstroms, the fluorescein will fluoresce at a wavelength of 5,200 Ångstroms. Thus by using the proper filters, an observer has an instantane-

ous indication of cell viability in the form of membrane integrity.

When cells have ice inside, the ice crystals scatter certain forms of illumination, making these cells appear bright against a dark background. The fluorescent dye technique can then be used both as a viability assay and as a means of detecting intracellular ice. Since intracellular ice is a lethal condition, the fraction of cells with intracellular ice can be subtracted from the survival signature to determine the effects of concentrated solutes on cell survival during freezing. The illustration at the left shows the results for HeLa S-3. While we would have expected the survival associated with salt concentration effects to be higher at the higher cooling velocities, the results are in accord with the two-mechanism hypothesis.

The results of the experiments with HeLa cells and those of similar experiments with human red blood cells and mouse embryos demonstrate the capability of the cryomicroscope in quantifying the events associated with freezing and thawing. With this instrument it is now possible to evaluate the survival signature and to determine the conditions requisite for intracellular ice in virtually any cell type. However, as one might expect, the experimental effort associated with such an undertaking would be overwhelming. An alternative approach would be to develop models that predict the physiochemical conditions leading to intracellular ice and the concentration of solutes. Since cell water plays such a key role in determining the response of a given cell type to freezing and thawing, the natural starting point in this analytical approach is to develop a model describing the transport of cell water across the membrane during freezing. Such models have been developed recently and have been used with some success to predict the formation of intracellular ice.

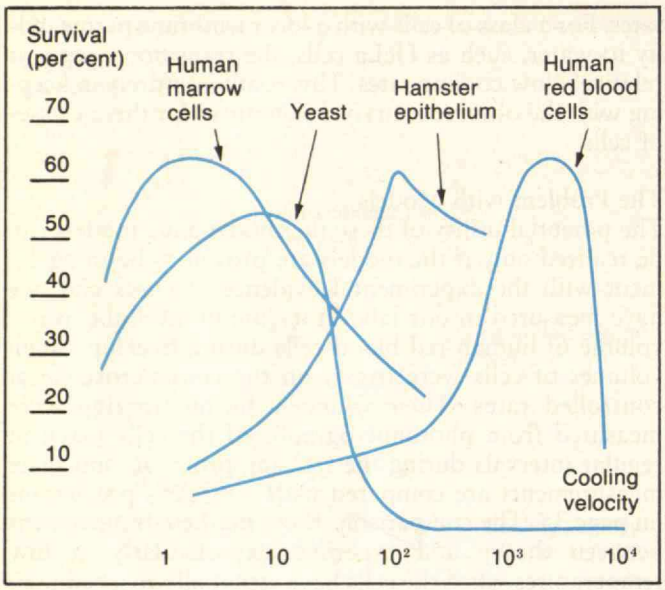
The results of this modeling show clearly the competition between the heat-transfer process by which the temperature of the suspending medium is reduced, and the mass-transfer process by which trans-membrane equilibrium is achieved. At low cooling velocities (less than 3,000°C per minute for human red blood cells), the mass transfer dominates and trans-membrane equilibrium is readily achieved. At high cooling rates, heat transfer dominates and the temperature of the system drops before trans-membrane equilibrium can be achieved. The analysis also shows clearly the role of membrane permeability in the whole process. For cells with a high membrane permeability to water, such as human red blood cells, the transition from mass-transfer dominance to heat-transfer dominance occurs at relatively high cooling rates. For a class of cells with a low membrane permeability to water, such as HeLa cells, the transition occurs at relatively low cooling rates. This result is entirely in keeping with the observed survival signatures for these classes of cells.

The Problem with Models

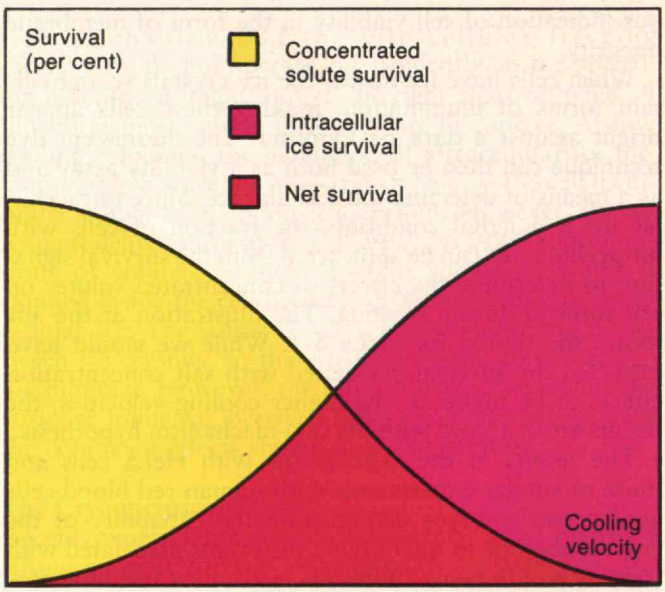
The potential utility of these thermodynamic models can be realized only if the models are proven to be in agreement with the experimental evidence. To this end, we have measured in our laboratory the intracellular water volume of human red blood cells during freezing. Small volumes of cells were frozen on the cryomicroscope at controlled rates. Their volumes during freezing were measured from photomicrographs of the cells taken at regular intervals during the freezing protocol, and these measurements are compared with a model's predictions on page 35. The comparison shows marked disagreement between theory and experiment, particularly at low temperatures when the cells have essentially reached their steady-state volumes. For cooling rates less than 100°C per minute, the theory predicts a final intracellular water volume of approximately 5 per cent of its initial value, while the experimental measurements show this value to be approximately 80 per cent. Even in light of the extreme difficulty of obtaining such experimental data, it is difficult to attribute this huge discrepancy solely to experimental error. Furthermore, the experimental findings are consistent with observations of other investigators who have simulated in non-freezing experiments the solute concentration effects associated with freezing. Their data indicate that at least 20 to 32 per cent of intracellular water is not free to participate in the osmotic equilibration process. Thus a substantial part of the discrepancy must be attributed to the theoretical models.

Further studies in our laboratory have shown that the deficiencies of the theoretical analysis lie not with the thermodynamic models themselves, but rather with the methods employed to obtain the water permeability figures used in the model. The water permeability decreases much more rapidly with decreasing temperature than one would expect from the extrapolation of room temperature permeability data. In effect the membrane shuts off the flow of water very rapidly as the temperature is decreased, and a major portion of intracellular water is retained even at the very lowest temperatures.

In spite of the present model's problems, we can still use it to quantify the conditions favoring intracellular ice by coupling it with a model for the kinetics of ice forma-



The left chart shows "survival signatures" for four types of cells; the percentage of cells surviving a cycle of freezing and thawing is plotted against the "cooling velocity" — the rate at which temperature decreases after the first appearance of ice. Each curve falls away at either side from a survival maximum, suggesting that there are two causes of cell death, one especially lethal at low cooling velocities, the other at high cooling velocities. This is shown schematically in the second illustration, where two mechanisms are suggested: At low cooling velocities, ice first forms outside the cells, and the extracellular concentration of solutes increases, causing water to leave the cells. As a result, the intracellular concentration of solutes increases and may cause damage. At high cooling velocities, ice forms within the cells and apparently disrupts them, though the specific mechanism is unknown.



tion. Two mechanisms are possible. In one case, known as homogeneous nucleation, formation is initiated in a liquid when embryos of critical radius are formed. (In the present context, an embryo is an aggregate of water molecules, and an embryo of critical radius is one that will continue to grow rather than break up, as do embryos of subcritical radius.) In the other case, known as heterogeneous nucleation, formation occurs on the surface of impurities in the liquid. The temperature at which nucleation occurs tends to be higher in the heterogeneous case. Heterogeneous nucleation is therefore much more likely to occur in cooling cells.

The illustration on page 36 shows the results of an analysis for human red blood cells containing spherical impurities of various sizes. The freezing temperature at a given cooling rate increases with impurity size, as one might expect. For any given impurity size, the shift from low to high freezing temperatures as the cooling velocity increases is a manifestation of the restriction on the transport of water imposed on the cell by the cell membrane. This analysis is in relatively good agreement with the available experimental data, in spite of the aforementioned limitations. It therefore seems possible to predict the cooling velocities at which intracellular ice is likely to occur. These calculations will be refined further as better permeability data become available.

Cryophylactic Agents

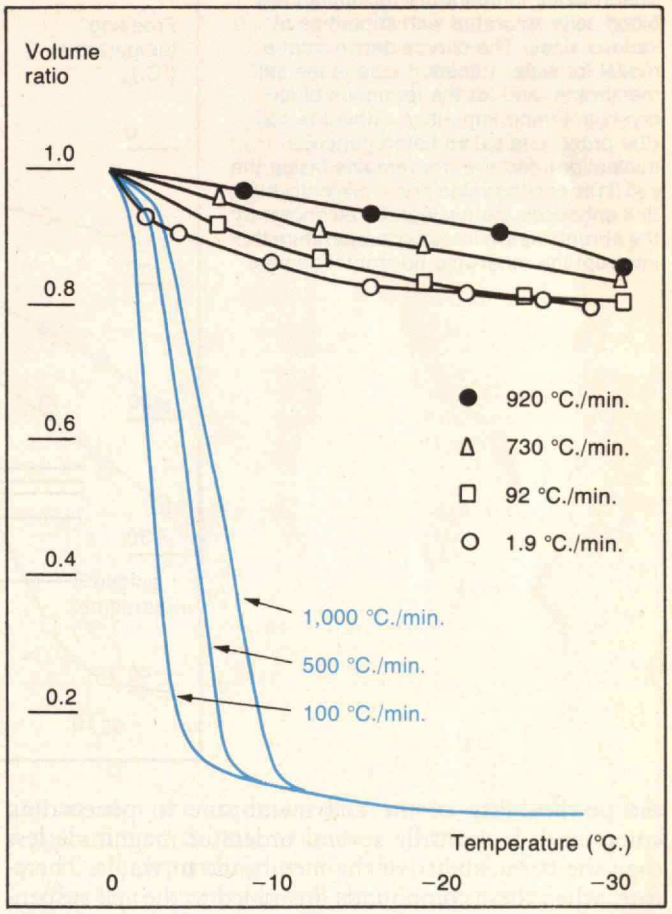
All of the work discussed thus far pertains only to cells suspended in their natural media. On the basis of these studies, one can conclude that cells can be reversibly frozen provided that the cooling velocity for optimum survival is employed in the freezing protocol. The available data show that in some cases, considerable control must be exercised over the freezing process if this optimum velocity is to be realized. In the clinical setting, the vol-

ume of the sample can result in suboptimal cooling velocities in some regions and supraoptimal cooling velocities in others. Thus cell survival will be less than optimum on the whole. What is needed is a means to modify the survival signature so that cells are less susceptible to the injurious effects of solute concentration and intracellular ice. It was while searching for just such a means that Polge, Smith, and Parkes discovered the cryoprotective action of glycerol. Further research has shown that many compounds have this effect on cell suspensions during freezing. They include low-molecular-weight sugars like sucrose and dextrose, and high-molecular-weight polymers like polyvinylpyrrolidone and polyethylene glycol. In all, some 55 compounds are known to exhibit cryophylaxis, and undoubtedly many more will be discovered.

In general, these compounds can be grouped into two broad categories: substances that penetrate the cell membrane and substances that do not. Early experience with cryophylactics seemed to indicate that the compound must penetrate the cell membrane to be effective, but significant improvements in cell survival have been obtained with nonpenetrating additives such as the sugars and the polymers. As shown on page 37, the primary effects are two-fold: they tend to "smear out" the survival signature and render the cell less sensitive to cooling velocity; and they tend to shift the cooling velocity for maximum survival to lower values which can more readily be achieved in clinical situations.

The precise mechanisms by which cryophylactics afford protection to living cells are not well understood, but it is generally believed that penetrating compounds like glycerol and dimethylsulfoxide afford their greatest protection at low cooling velocities where they minimize cell dehydration by acting as water substitutes. On the other hand, non-penetrating compounds like the sugars and the polymers afford their greatest protection at high cooling velocities where they minimize the effects of intracellular ice nucleation by moderating ice-crystal growth.

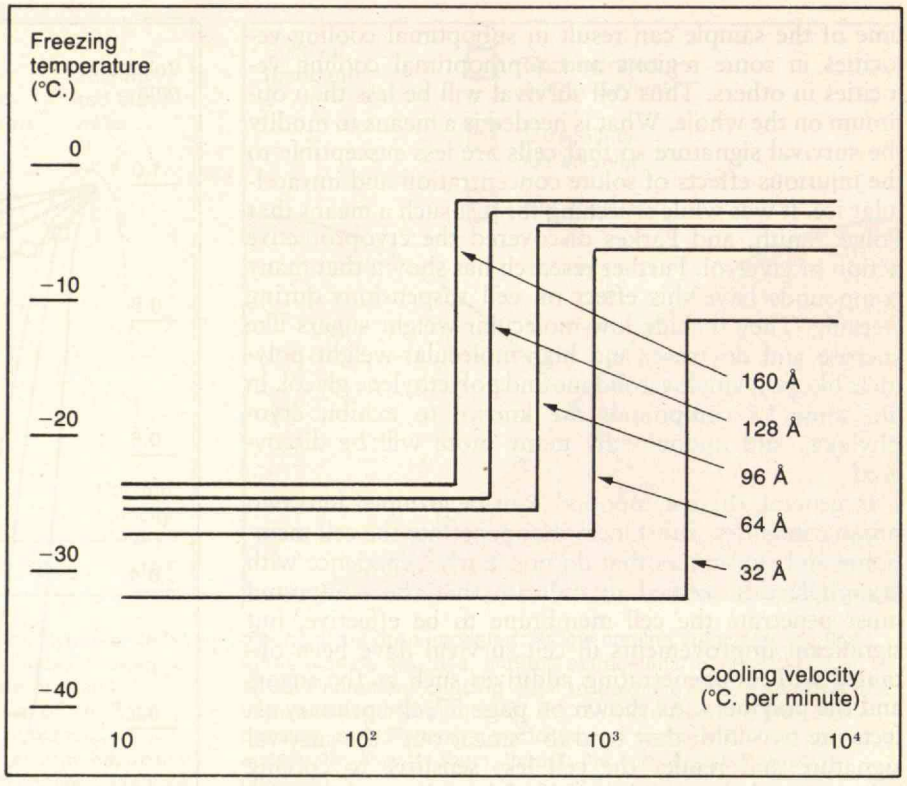
The use of cryophylactic agents in the long-term preservation of biomaterials requires a great deal of experimentation to determine the optimum compound and concentration for a given application. What may be best for one cell type may not necessarily be best for another. For example, one concentration of glycerol affords optimum cryophylaxis for human red blood cells frozen slowly, but mouse embryos can be preserved quite satisfactorily at low cooling rates with a very different concentration of dimethylsulfoxide. The specificity of the effect is most likely due to the variation in membrane permeability to a given compound.



The intracellular volume of human red blood cells is plotted as temperature decreases; the data are shown as a fraction of the volume before the onset of freezing. Curves at the top of the chart display measurements made in the author's laboratory; curves at the bottom, unfortunately, are predictions from a computer model. The enormous discrepancy apparently occurs because the outflow of water shuts off at low temperatures, invalidating extrapolations from room-temperature data on membrane permeability.

While these compounds greatly increase the potential for long-term preservation by freezing, they are not the panaceas they might appear to be. They introduce a new class of problems which sometimes may be more complex than the problems of freezing injury *per se*. For example,

The freezing temperature for human red blood cells saturated with impurities of various sizes. The curves derive from a model for water transport across the cell membrane, and for the formation of ice crystals around impurities within the cell (the process is called heterogeneous nucleation). More water remains inside the cell if the cooling velocity is sufficiently high; this enhances the nucleation, as shown by the abrupt rises in freezing temperature that interrupt the otherwise horizontal curves.



the permeability of the cell membrane to penetrating compounds is typically several orders of magnitude less than the permeability of the membrane to water. Therefore, when these compounds are added to the cell suspension, the cell responds rapidly by transporting water across its membrane into the extracellular medium. If the initial concentration of cryophylactic agent is too large, the resulting cell volume decrease will be such that the intracellular concentration of solutes reaches a lethal level.

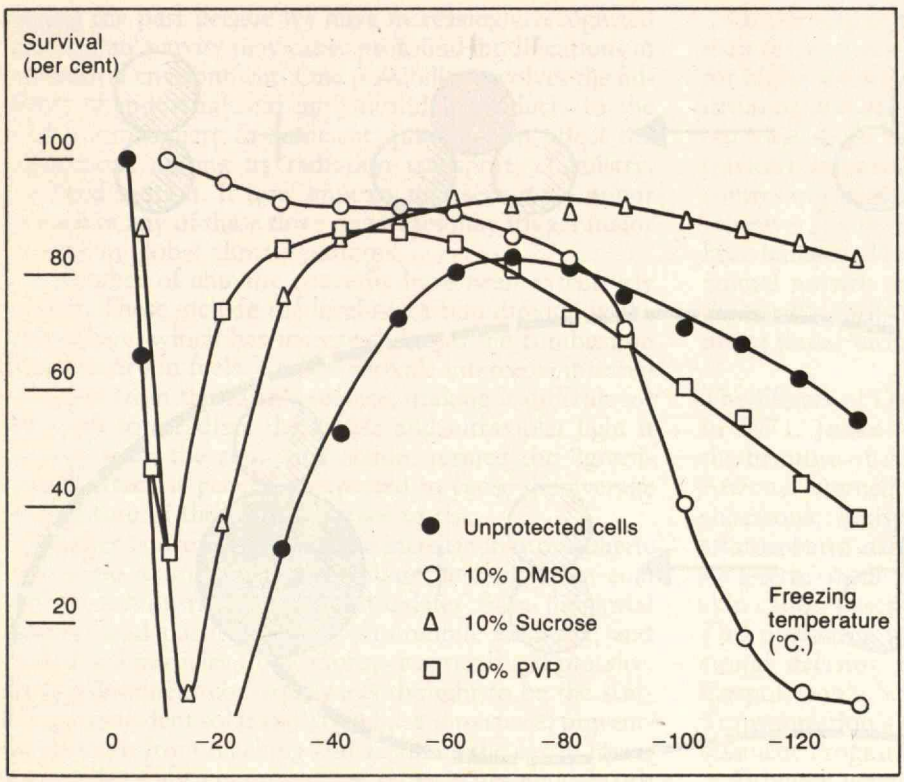
Cryophylactic compounds may also compete with other prefreeze additives. For example, in the clinical freezing of human red blood cells, the blood must be collected in some sort of anticoagulant medium. Two types of anticoagulants find widespread usage today — ACD (Acid-Citrate-Dextrose) and CPD (Citrate-Phosphate-Dextrose). The prefreeze addition of glycerol to red blood cells collected in CPD must proceed more slowly than is the case for blood collected in ACD. Presumably the transport of glycerol across the cell membrane is moderated by the presence of CPD in a way that increases the likelihood of damage to the cells even before freezing.

Before cells treated with penetrating compounds can be used clinically, it is usually necessary to remove the compounds after thawing the cell suspension. Again, osmotic damage can result. When cells laden with cryophylactic agent are reintroduced into their normal medium, extracellular water rushes into the cell in order to restore equilibrium, and the cell swells to the bursting point.

Finally, some cryophylactic compounds may be toxic in the concentrations necessary to afford protection, and these effects must be considered most carefully before clinical application is attempted.

The Search for Better Cryophylactic Agents

In this article, we have concentrated on the difficulty of using low temperatures for the long-term preservation of biomaterials. It might appear that a multitude of problems remain to be solved, so that clinical application of cryobiology lies somewhere in the distant future. Fortunately, this is not the case. At the Massachusetts General Hospital in Boston, alone, more than 50,000 units of frozen blood cells have been used clinically in the past



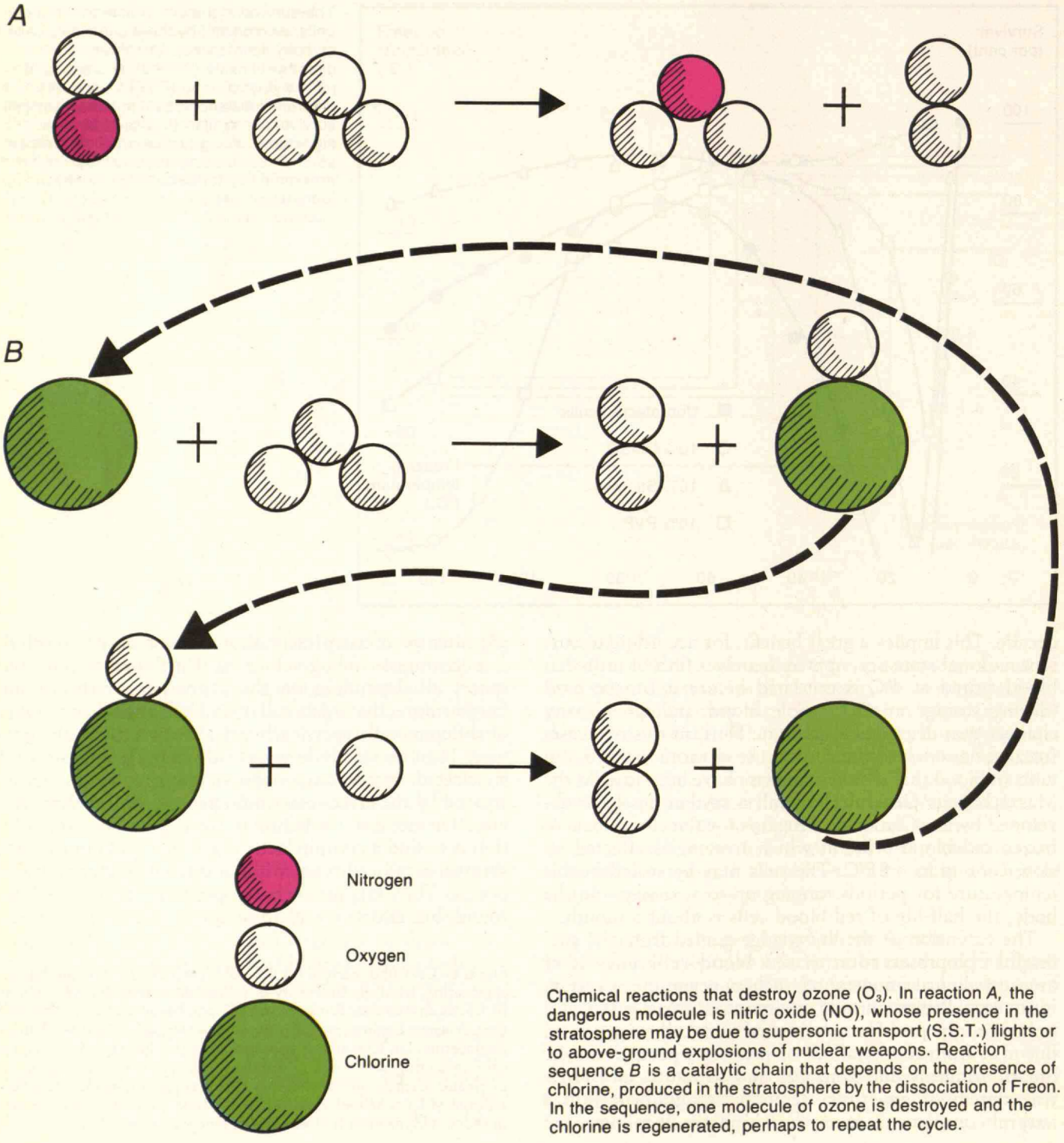
The survival signature of human red blood cells, as modified by three chemicals called cryophylactic agents. The three — dimethysulfoxide (DMSO), sucrose, and polyvinylpyrrolidone (PVP) — are very different substances, but their effects on cell survival are similar: they broaden the signature, making the dropoff from maximum survival less precipitous, and they move the maximum to a lower cooling velocity that is more easily achieved.

decade. This implies a great benefit, for according to current national statistics, approximately a fifth of unfrozen blood stored at 4°C is outdated before it can be used (during storage at 4°C, whole blood undergoes many changes that degrade its quality). Thus, in this one case, freezing has enabled the clinical use of more than 10,000 units of blood that would otherwise have been lost. At the Massachusetts General Hospital, a system has been developed by Dr. Charles E. Huggins for the clinical use of frozen red blood cells, in which freezing is effected by slow cooling to −85°C. The cells may be stored at this temperature for periods ranging up to two years. In the body, the half-life of red blood cells is about a month.

The extension of the knowledge gained from the successful cryopreservation of red blood cells into other areas of clinical importance, such as organ preservation, is not easy. Preservation of an organized tissue suffers not only from the problems associated with cell suspensions, but also from a special set of problems peculiar to the organ, primarily due to its size and structure. In a physical system of any bulk, temperature gradients are a natural consequence of any heat transfer. It follows that any attempt at cryopreservation of an organ will result in a spectrum of cooling velocities, distributed in time and space, all depending on the properties of the organ. Furthermore, the organ will most likely include a number of different cell types, each with its own survival signature. Then no matter how carefully the freezing protocol is selected, some components of the organ may be destroyed by the cryopreservation process while others survive. The net result is failure of the organ. The only solution is to find a cryophylactic agent that will improve the survival of all cell types without introducing undesirable effects. Thus far, no such cryophylactic agent has been found, but efforts are continuing.

Ernest G. Cravalho received his B.S., M.S., and Ph.D., all in mechanical engineering, from the University of California at Berkeley. He came to M.I.T. as an Assistant Professor in 1967 and began his association with the Cryogenic Engineering Laboratory in the Department of Mechanical Engineering. Dr. Cravalho is currently Associate Professor of Mechanical Engineering, and a faculty member of the Harvard-M.I.T. program in Health Sciences and Technology. He was recently named Associate Dean of M.I.T.'s School of Engineering, within which he is participating in the development of a biomedical engineering curriculum.

A layer of ozone shields the earth from harmful ultraviolet radiation — but molecules from aircraft exhaust, Freon gas, agricultural chemicals, and nuclear-weapon explosions may now be attacking it.



Chemical reactions that destroy ozone (O_3). In reaction *A*, the dangerous molecule is nitric oxide (NO), whose presence in the stratosphere may be due to supersonic transport (S.S.T.) flights or to above-ground explosions of nuclear weapons. Reaction sequence *B* is a catalytic chain that depends on the presence of chlorine, produced in the stratosphere by the dissociation of Freon. In the sequence, one molecule of ozone is destroyed and the chlorine is regenerated, perhaps to repeat the cycle.

Charles E. Kolb
Aerodyne Research, Inc.

The Depletion of Stratospheric Ozone

During the past decade we have increasingly recognized that human activity may cause profound modifications in the natural environment. One possibility involves the addition of industrial and agricultural byproducts to the earth's atmosphere in sufficient quantities to affect the interactions among its radiation transport, chemistry, and fluid motion. It now appears that seemingly minor changes in any of these three quantities may trigger major changes in global climate patterns.

A number of climatic concerns have been extensively studied. These include the level of carbon dioxide in the atmosphere, which has increased due to the combustion of hydrocarbon fuels. Carbon dioxide intercepts infrared radiation from the earth's surface, making it difficult for the earth to reradiate the visible and ultraviolet light it receives from the sun. This action, termed the "greenhouse" effect, is generally expected to cause the average temperature of the earth's surface to rise.

Another concern has been the increase in atmospheric particulate matter, including sulfate aerosols from coal and oil combustion, metal particulates from industrial activity, lead particules from automobile exhausts, and eroded soil particles from improper agricultural practice. The predominent consequence is thought to be the scattering of incident solar radiation back into space, preventing the light from reaching and warming the earth. However, under some circumstances, particulates may absorb enough solar radiation to cause warming, and they may also trigger cloud formation, with further effects on climate. There has been speculation that the greenhouse effect and the particulate scattering effects are partially cancelling each other, thus preventing any major change in the average annual temperature.

A third concern involves the discharge of waste heat into the atmosphere. In some portions of the U.S., this discharge now equals between one and five per cent of the average solar energy deposited in the same region. That magnitude may well be sufficient to trigger significant variations in atmospheric motion and water-vapor content, causing climatic change well beyond the immediate region of the heat release.

The climatic implications of carbon dioxide, particulate matter, and heat are at least in part predictable. More recently, a great deal of research effort has been directed at a fourth and more complex area of atmospheric concern: the apparent fragility of the stratospheric ozone layer which shields the earth's surface and lower atmosphere from most of the ultraviolet solar radiation between 2,300 and 3,200 Ångstrom units.

Ozone (O_3) is formed from three oxygen atoms rather than the two contained in the oxygen molecule necessary for higher animal life. It is a very reactive form of oxygen, irritating and unhealthy in the lower atmosphere's smog, but vital in the upper atmosphere, where it absorbs ultraviolet radiation. The importance of this ozone shield in controlling climatic parameters is not precisely known. However, its destruction might change the atmosphere's heat balance. There also might be changes in plant and animal growth due to increased ultraviolet radiation at the earth's surface. Indeed, there might be a serious and direct threat to human health.

The Effects of Ozone-Layer Depletion

In 1971, James McDonald, a physicist associated with the Institute of Atmospheric Physics at the University of Arizona, warned that water in the exhaust of a fleet of supersonic transport aircraft (S.S.T.s) might attack the stratospheric ozone layer. McDonald estimated that a long-term ozone reduction of one per cent would increase skin cancer cases in the United States by 8,000 per year. This prediction was an important factor in the Congressional decision to postpone the financing of Boeing Corporation's S.S.T., and to fund the Department of Transportation's recently completed Climatic Impact Assessment Program (C.I.A.P.).

Although water now ranks relatively low in the hierarchy of recognized chemical threats to the ozone layer, McDonald's correlation of ozone decrease with skin cancer incidence remains the best documented environmental effect of decreasing the ozone layer. Careful studies of this correlation were performed during C.I.A.P. by utilizing the natural variation of O_3 density with latitude, which creates a ground-level, latitude-dependent variation in ultraviolet flux. Measured fluxes at a number of latitudes were carefully correlated with local levels of skin cancer incidence by F. Urbach and co-workers at Temple University's Skin and Cancer Hospital. From this data, they constructed a model which predicted that the percentage of new skin cancer cases would increase by approximately double the percentage decrease in average ozone column density. Thus, a 5 per cent decrease in the ozone layer is predicted to result in a 10 per cent increase in new skin cancer cases per year. This two-for-one correlation is expected to hold for reductions in O_3 levels up to approximately 50 per cent.

Since ultraviolet radiation appears to induce skin cancer slowly and cumulatively, the full percentage increase in cancer cases would not appear until about 20

years after a sudden decrease in the ozone layer. But by the same token, skin cancer incidences would remain above normal for at least 60 years if a sudden drop in ozone levels was just as suddenly eliminated. Using Urbach's correlation, a permanent 5 per cent reduction in O_3 would eventually result in about 31,000 new skin cancer cases per year in the United States.

The most prevalent type of skin cancer associated with ultraviolet radiation is relatively common — about 250 cases per 100,000 occur in fair-skinned Caucasians in the United States. The cancer is assumed to be the result of genetic damage caused when DNA molecules in the skin cells absorb the radiation. (Skin pigments preferentially absorb it without damage, thus screening DNA in dark-skinned people from harm.) This type of cancer is rarely fatal if treated; treatments, however, can be both costly and unpleasant. A rarer and far more dangerous form of skin cancer, melanoma, is also associated with ultraviolet radiation, and can be expected to increase with decreases in ozone shielding at about the same relative rate as non-melanoma skin cancer.

Although skin cancer is the best documented effect of ozone depletion, it is not necessarily the most serious. Other effects of increased ultraviolet intensities studied in C.I.A.P. include crop-plant response, biologic effects on aquatic and soil microorganisms, noncancer health effects, and the economic aspects of increased weathering of exterior materials. None of these studies were definitive; still, laboratory tests did show that increased ultraviolet irradiation causes a number of domesticated crop plants to produce less biomass, and adversely affects a wide variety of organisms including bacteria, algae, protozoa, small invertebrates, and vertebrates in early developmental stages. A great deal more research must be performed before anyone can completely specify the environmental impact of ozone depletion.

Similarly, only preliminary estimates have been made on the economic impact of any ozone-related environmental effect. For instance, ultraviolet radiation is known to speed surface deterioration in a number of man-made materials, including paints, plastics, and fabrics. The magnitude as well as the economic effect of these shortened lifetimes remain to be determined.

Finally, there is no guarantee that ozone depletion, through its direct effect on atmospheric structure and temperature and its secondary effect on vegetation patterns, will not result in significant changes in the global climate. Far too little is currently known about the complex atmospheric interactions between chemistry, radiation, and transport properties to predict what the total climatic effect of ozone layer depletion might be.

Atmospheric Structure and the Ozone Layer

Since atmospheric chemistry is not commonly studied, even by professional chemists, a short discussion of atmospheric structure and the photochemical mechanism responsible for producing and maintaining the stratospheric ozone layer is presented below. This is followed by a review of the man-made chemicals that now seem to threaten this vital atmospheric component.

The illustration on page 42 shows a typical temperature-height profile of the atmosphere. The temperature typically decreases monotonically from the ground to an altitude of approximately 10 kilometers, where it reaches a minimum in a region called the tropopause. The height of the tropopause varies with latitude, season, and weather, and may be as low as 8 kilometers in Arctic regions and as high as 18 kilometers in tropical regions. Below it is the troposphere, containing the great bulk of human activity. Above it, the atmospheric temperature increases to a maximum at the stratopause, about 50 kilometers above the surface. The shell of atmosphere between the tropopause and the stratopause is defined as the stratosphere. It contains the ozone layer, which usually reaches a maximum density between 20 and 30 kilometers above the surface, or about halfway between the tropopause and the stratopause. Above the stratopause, the atmospheric temperature again decreases until it reaches a minimum at the mesopause, about 85 kilometers in altitude. The atmospheric shell between the mesopause and the stratopause is designated as mesophere, while the outermost atmospheric shell above the mesopause is termed the thermosphere. Here, kinetic temperatures in the tenuous atmosphere can reach several thousand degrees Kelvin in response to solar activity.

The basic photochemical processes responsible for formation of the ozone layer were elucidated by Chapman 45 years ago. The cycle begins when molecular oxygen, O_2, is photodissociated by solar photons with wavelengths shorter than 2,424 Ångstroms ($h\nu$ signifies the frequency, ν, of the photon, multiplied by Planck's constant, h, to give the energy that the photon contributes to the reaction):

$$O_2 + h\nu \rightarrow O + O \qquad (1)$$

This reaction is very important in the upper stratosphere,

the mesosphere, and the lower thermosphere. It causes most of the atmospheric oxygen above approximately 100 kilometers to exist as atoms rather than O_2 molecules.

Two oxygen atoms can recombine to reform molecular oxygen with the help of a third atom or molecule (here signified by M) to carry away some of the energy that is released:

$$O + O + M \rightarrow O_2 + M \qquad (2)$$

However, oxygen atoms below roughly 90 kilometers are more likely to combine with molecular oxygen and, with the help of a third body, form ozone:

$$O + O_2 + M \rightarrow O_3 + M \qquad (3)$$

Ozone itself photodissociates at wavelengths shorter than 3,600 Ångstroms:

$$O_3 + h\nu \rightarrow O_2 + O \qquad (4)$$

By this process, the ozone shield removes most of the solar radiation shorter than 3,200 Ångstroms that reaches the stratosphere.

Most of the atomic oxygen liberated in reaction 4 is quickly recycled back to O_3 by reaction 3. However, some can be lost by the reaction:

$$O + O_3 \rightarrow 2\ O_2 \qquad (5)$$

Reaction 5 in concert with reaction 4 effectively prevents more than a small fraction of the stratospheric oxygen from turning into ozone. The peak in the stratospheric ozone distribution is due to a trade-off in the rates of reactions 1 and 4 — which occur more quickly at higher altitudes where ultraviolet photons are more plentiful — and reaction 3, which is fast at lower altitudes where the total pressure is higher.

A second feature of reactions 1 and 4 is that the kinetic energy of their products leads to the stratospheric reversal of the temperature drop-off with increasing altitude found in both the troposphere and mesosphere. This temperature inversion makes it difficult for stratospheric molecules to diffuse down to the troposphere. Thus any gaseous pollutants released within the stratosphere tend to be trapped.

Kinetic analysis of reactions 1 through 5 shows that stratospheric levels of O_3 and atomic oxygen reach a steady state during the daytime, and that nearly all of the stratospheric atomic oxygen is converted to O_3 at night. This intimate relationship between atomic oxygen and ozone means that chemicals that destroy either O_3 or O in the stratosphere will lead to a diminution of the ozone layer. Indeed, it has long been suspected that trace chemicals in the stratosphere interfere in the ozone cycle, and ambitious three-dimensional calculations of stratospheric photochemistry and transport recently reported by Ronald Prinn, Norman Phillips, and their co-workers at M.I.T.'s Meteorology Department confirm the crucial impact of trace species chemistry on ozone levels.

Ozone and Water Vapor

Although the stratosphere is comparatively dry and usually colder than the freezing temperature of water, some free water vapor arrives from the troposphere by upward transport and some is created by the oxidation of H_2 and CH_4 which have diffused through the tropopause. Moreover, water vapor is injected into the stratosphere by exhaust gases from rockets and high-altitude aircraft — in particular, from S.S.T.s, which fly at stratospheric altitudes.

Water vapor can react with ^1D oxygen atoms — that is, oxygen in which an electron has been raised from its lowest-energy p orbital with unpaired electronic spin to another p orbital where its spin is paired. (Such electronically excited atoms, denoted here by $O(^1D)$, are often created by reaction 4.) In this reaction, the product is hydroxyl radicals — molecules that are highly reactive:

$$O(^1D) + H_2O \rightarrow 2\ OH \qquad (6)$$

Hydroxyl radicals are also created when water vapor is photolyzed (dissociated) by ultraviolet radiation:

$$H_2O + h\nu \rightarrow OH + H \qquad (7)$$

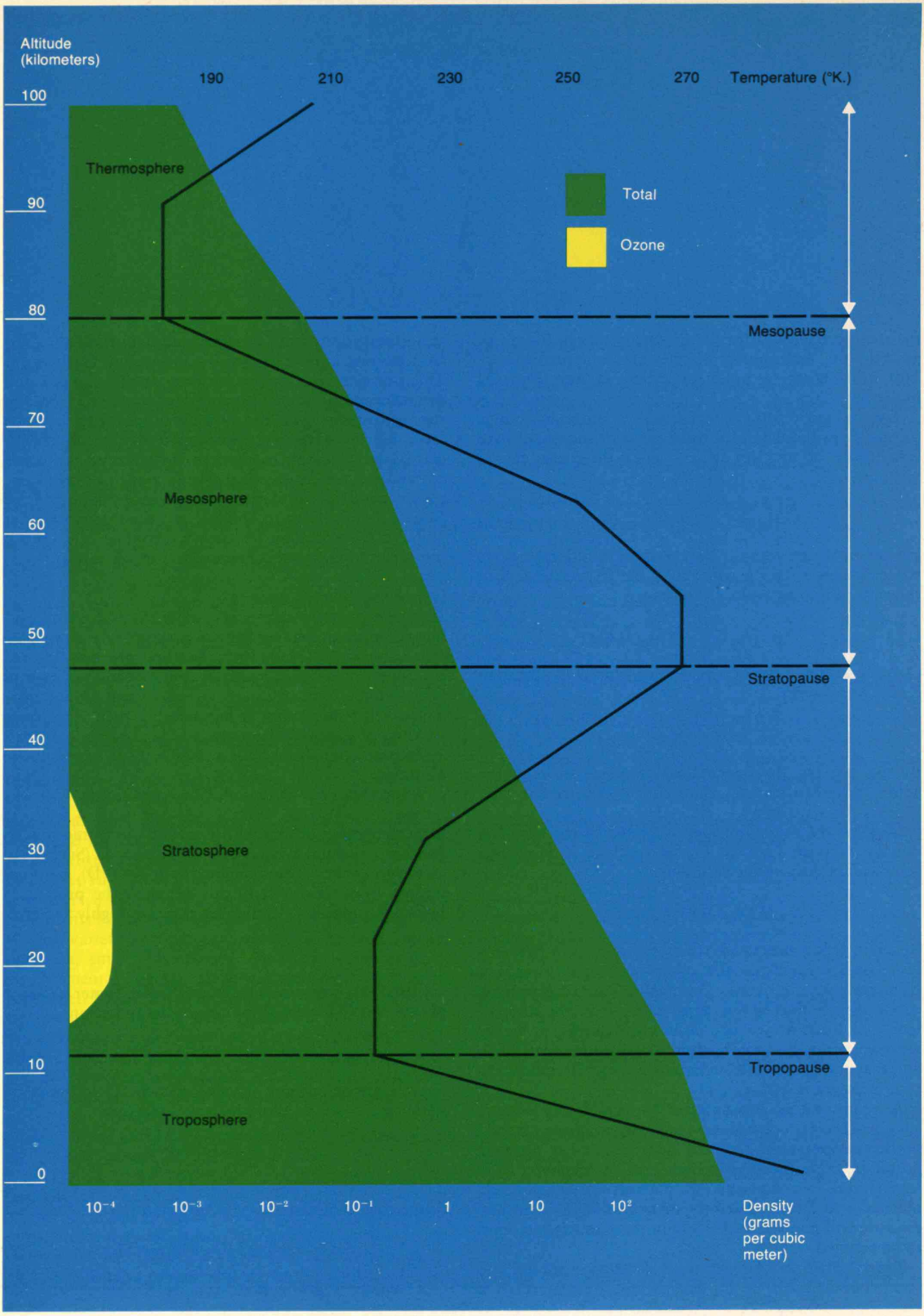
Here, hydrogen atoms are also created. They can react with ozone to form more hydroxyl radicals:

$$O_3 + H \rightarrow OH + O_2 \qquad (8)$$

or can combine with molecular oxygen to form hydroperoxyl radicals:

$$O_2 + H + M \rightarrow HO_2 + M \qquad (9)$$

A number of atmospheric chemists have suggested that


Altitude
(kilometers)
190
210
230
250
270
Temperature (°K.)
100
90
80
70
60
50
40
30
20
10
0
Thermosphere
Total
Ozone
Mesopause
Mesosphere
Stratopause
Stratosphere
Tropopause
Troposphere
10^{-4}
10^{-3}
10^{-2}
10^{-1}
1
10
10^{2}
Density
(grams
per cubic
meter)

The density of ozone is contrasted with that of the entire atmosphere. Ozone is seen to form a layer with a maximum density between 20 and 30 kilometers above the surface, though the distribution varies with latitude and with the seasons. The total amount, however, is never large: if the ozone were concentrated and brought to the pressure of the atmosphere at the surface, it would form a layer only about 0.3 centimeters thick. Also shown in the diagram are the zones of the atmosphere as determined by temperature, which falls through the troposphere, rises through the stratosphere, falls through the mesosphere, and rises through the thermosphere, where the sun's radiation gives large amounts of kinetic energy to lonely molecules.

the hydroxyl and hydroperoxyl radicals formed from water vapor may participate in a catalytic chain mechanism which destroys ozone. This mechanism is shown by the reactions:

$$OH + O_3 \rightarrow HO_2 + O_2 \qquad (10)$$

and

$$HO_2 + O_3 \rightarrow OH + 2\,O_2 \qquad (11)$$

The net result of reactions 10 and 11 is the conversion of two O_3 molecules into three O_2 molecules, and the regeneration of the hydroxyl radical to start the chain again. A catalytic chain such as this could easily allow a little OH to destroy a lot of ozone if the rates for reactions 10 and 11 were fast compared to the rates of reactions that destroy OH.

Although conclusive laboratory data is not yet available, it appears that the rates for reactions 10 and 11 are not fast enough at stratospheric temperatures to affect O_3 concentrations significantly. However, both OH and HO_2 can react with atomic oxygen that might otherwise have become ozone:

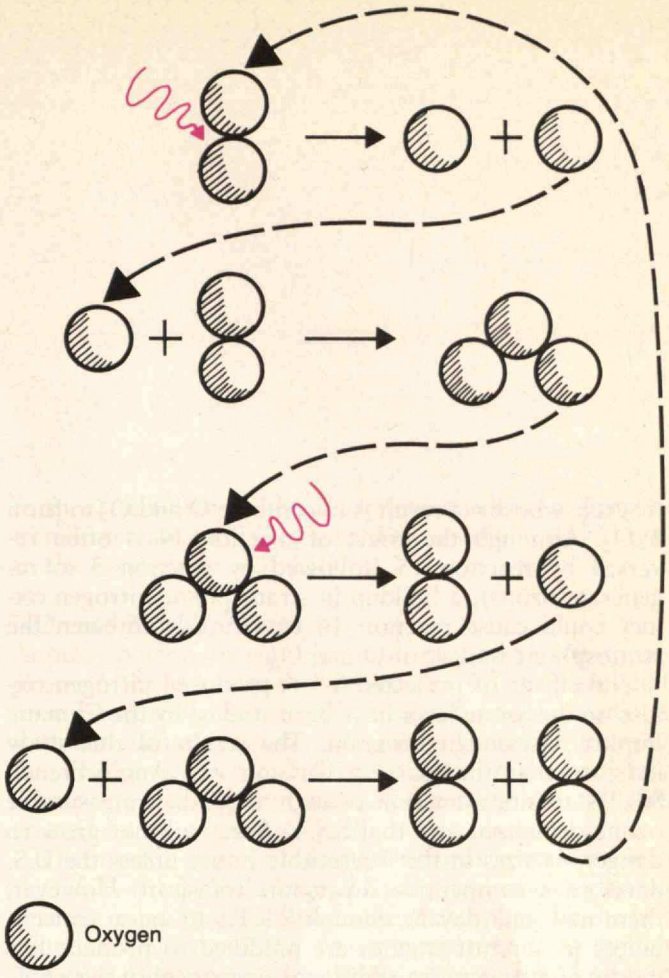
$$O + OH \rightarrow O_2 + H \qquad (12)$$

$$O + HO_2 \rightarrow OH + O_2 \qquad (13)$$

Reactions 12 and 13 (coupled with reactions 7 through 11) do appear to reduce stratospheric O_3 below levels predicted by reactions 1 through 5, at altitudes above 50 kilometers. However, the amount of water vapor deposited in the stratosphere by proposed human activities would probably be a small fraction of the amount transported by natural processes, so ozone depletion due to water from S.S.T. and other stratospheric craft should not be significant. Strangely enough, exhaust gases produced by current aircraft engines at less than a hundredth of the water production rate are now known to be a far more serious threat.

Ozone and Nitrogen Oxides

Studies published in 1970 and 1971 by P. J. Crutzen, now at the National Center for Atmospheric Research, and by H. S. Johnston of the University of California, called forceful attention to the danger that nitrogen oxides present in aircraft exhausts could attack the stratospheric ozone layer. Two major forms of nitrogen oxide — nitric oxide, or NO, and nitrogen dioxide, or NO_2 — usually attain a steady state, like O and O_3, under stratospheric conditions. Their concentrations are related by the reactions:



The natural cycle that forms and destroys ozone, as determined by Chapman a half-century ago. In the top reaction, molecular oxygen dissociates into atomic oxygen when hit by a photon of the appropriate energy. (The reverse reaction also occurs, but is uncommon in the stratosphere.) In the second reaction, molecular and atomic oxygen combine to form ozone. But in the third reaction, the ozone is struck by a photon and dissociates. This photon is ultraviolet in wavelength, and by its absorption here, the ozone layer shields the earth. Ozone is also lost by the last reaction, in which two molecules of oxygen are formed.

$$NO + O_3 \rightarrow NO_2 + O_2 \qquad (14)$$

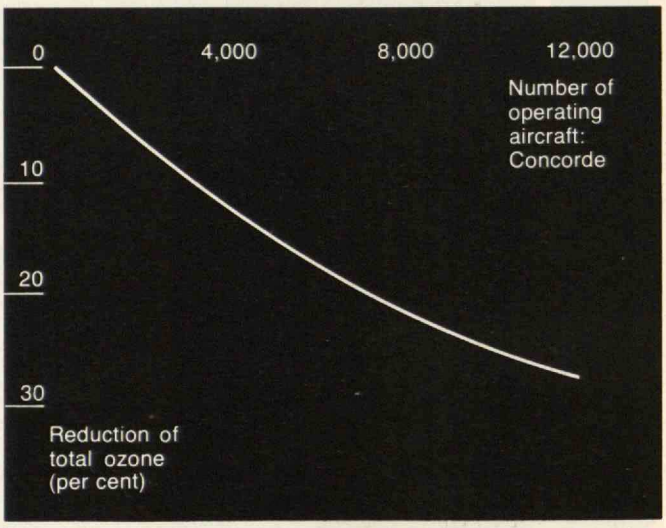
$$NO_2 + h\nu \rightarrow NO + O \qquad (15)$$

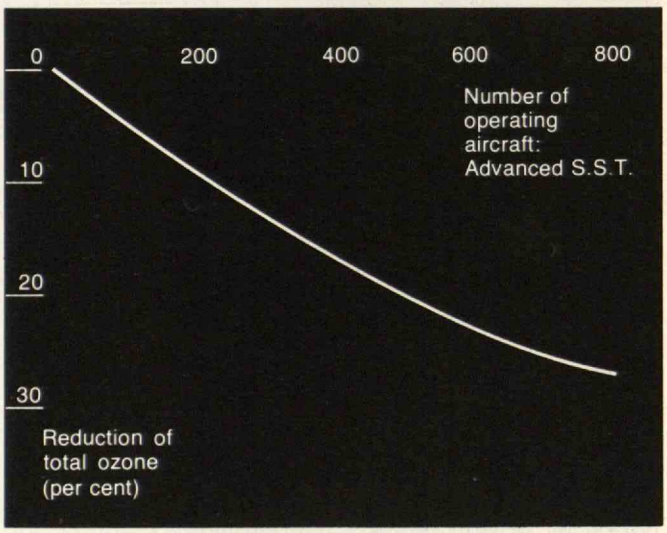
$$NO_2 + O \rightarrow NO + O_2 \qquad (16)$$

Like O to O_3, NO is almost completely converted to NO_2 at night. The sum of the species NO and NO_2, plus a few additional species such as nitrogen trioxide, NO_3, and nitric acid, HNO_3, are termed odd nitrogen species and are often designated NO_x.

Reactions 14 and 16 have relatively fast rates at stratospheric temperatures; they form an efficient cataly-

The potential impact of nitrogen oxides emitted by a fleet of Concorde S.S.T.s (top chart) and by a fleet of more advanced aircraft (bottom chart). For purposes of this calculation, performed by McElroy and co-workers, the Concorde is taken to carry a hundred passengers at an altitude of 17 kilometers. The chart suggests that the projected fleet of Concorde-like aircraft flying through the 1980s will have little effect on global ozone levels. The more advanced S.S.T., taken here to carry 600 passengers at an altitude of 20 kilometers, will be more dangerous.





tic cycle whose net result is to combine O and O_3 to form 2 O_2. Although the effect of reaction 14 is often reversed by reaction 15 (followed by reaction 3 to regenerate ozone), a buildup in stratospheric nitrogen oxides could cause reaction 16 to seriously threaten the stratospheric budget of O and O_3.

The effects of projected S.S.T.-produced nitrogen oxides on the ozone layer have been studied by the Climatic Impact Assessment Program. The results of this study indicate that the existing Russian and Anglo-French S.S.T.s are not numerous enough to produce measurable ozone depletion, and that S.S.T. fleets will not grow to dangerous sizes in the foreseeable future unless the U.S. develops a competitive supersonic transport. However, there may one day be enough S.S.T.s to cause concern unless jet aircraft engines are modified to produce less oxides of nitrogen. An additional assessment of the S.S.T. problem has recently been published by a committee of the National Academy of Sciences; this report reaches conclusions similar to those published in the final C.I.A.P. reports.

The charts on this page illustrate the potential impact of S.S.T.s on stratospheric ozone as calculated by McElroy and co-workers at Harvard University. Calculations are shown for the Anglo-French Concorde and for a hypothetical higher-flying S.S.T. similar to the one proposed by Boeing.

Natural NO_x Sources and Fertilizer Production

C.I.A.P. stimulated considerable research on other sources of stratospheric nitrogen oxides, and also the first measurements of natural stratospheric NO, NO_2, and HNO_3. (The last of these three molecules, nitric acid, is produced by the reaction:

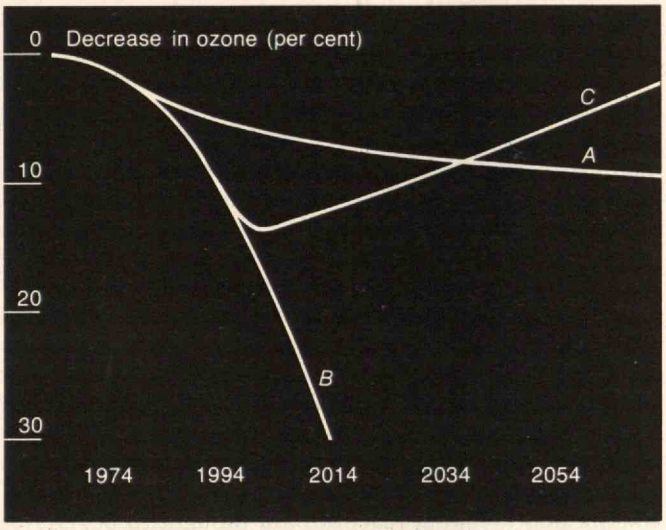
$$NO_2 + OH + M \rightarrow HNO_3 + M \qquad (17)$$

which may act as a sink for stratospheric nitrogen oxides.) Most studies have concluded that NO_x produced in the troposphere is removed by rainfall before it can penetrate the tropopause. However, one apparently significant source of natural stratospheric NO_x is the *in situ* oxidation of nitrous oxide, N_2O, by $O(^1D)$:

$$N_2O + O\ (^1D) \rightarrow 2\ NO \qquad (18)$$

McConnell has also discussed the possibility of ammonia oxidation as a significant stratospheric source of nitrogen oxides. Both nitrous oxide and ammonia are released into the troposphere as a result of microbial activity in the soil, and reach the stratosphere by upward diffusion. Additional natural stratospheric NO_x may be produced by the action of cosmic rays in the upper atmosphere. The possible magnitude of this source has been discussed by Warneck and by Ruderman and Chamberlain of Columbia University for current levels of cosmic radiation, while Ruderman has speculated on the consequences of increased cosmic radiation from a nearby supernova explosion. In addition, Crutzen has speculated that protons

Reductions in global ozone for three assumptions about future Freon use, as computed by Wofsy, McElroy, and Sze. Curve *A* assumes that the manufacture and release into the atmosphere of Freon (carbon bonded to chlorine and fluorine, and used as an aerosol propellant) continues at 1972 levels; curve *B* assumes a 10 per cent annual growth in Freon release; and curve *C* assumes a 10 per cent annual growth until 1995, followed by an abrupt end to Freon use. F. Urbach and co-workers at Temple University have estimated that each 1.0 per cent decrease in ozone will eventually result in a 2.0 per cent increase in the incidence of skin cancer. Other possible effects are not as well documented.



ejected from the sun during intense solar storms could produce NO_x levels comparable to the cosmic ray contribution.

The discussion of "natural" sources of stratospheric odd nitrogen has taken on new urgency in recent months due to the realization by McElroy and co-workers that industrial and agricultural activities may soon add amounts of fixed nitrogen (chiefly nitrate, NO_3^-) to the environment comparable to the amount normally and naturally fixed by bacteria and algae. Burns and Hardy of duPont have recently estimated that the total amount of atmospheric N_2 fixed (that is, bound to other chemical species) by the biosphere is 175 million tons annually. They also estimate that 40 million tons of N_2 is being fixed industrially each year by the Haber-Bosch process for the production of nitrate fertilizer, while 20 million tons is fixed by combustion processes as NO, which eventually rains out as nitrate.

It therefore appears that man-controlled, abiological processes currently introduce fixed nitrogen into the environment at about a third the rate of the biological processes which dominate natural nitrogen fixation. However, Hardy and Havelka estimate that 200 million tons of fertilizer nitrogen will be required annually by the end of this quarter-century. Now N_2O, mentioned above as the major source of stratospheric odd nitrogen, is produced from fixed nitrogen by several strains of denitrifying bacteria. If large additions of fixed nitrogen in the form of fertilizer to the biosphere result in a proportional increase in N_2O production, a serious new threat to the ozone layer will arise.

NO_x and Nuclear Bombs

Another potentially serious source of man-made stratospheric NO_x involves neither the S.S.T. nor industrial processes. Instead it involves the rising fireballs associated with atmospheric nuclear explosions. Abundant fluxes of the nuclear-produced nitrogen oxides are immediately transported to high altitudes by aerodynamic forces created by the explosion itself.

The topic of bomb-produced NO_x was introduced into the S.S.T. debate by Foley and Ruderman, who calculated that the quantity injected into the stratosphere by the last rounds of U.S. and Russian atmospheric tests (which ended in 1962) was of the same order as that expected during a year's operation of a 500-plane S.S.T. fleet. Foley and Ruderman further concluded that ozone column density measurements between 1960 and 1964 did not decrease in response to the 1961-62 bomb tests, a conclusion that was echoed after a similar study by Goldsmith and co-workers. However, the conclusion that nitrogen oxides produced by the 1961-1962 bomb tests did not affect the ozone layer has been seriously challenged by Johnston and co-workers, who have concluded that a careful study of ozone column records shows a gradual 5 per cent increase in total ozone column density over the period from 1963 to 1970. Johnston attributes this increase to the recovery of the natural ozone densities after depletion due to the nitrogen oxides from atmospheric weapons testing. Unfortunately, good ozone column measurements are not available from before 1952, so the pretesting levels of ozone density are unknown. The debate over what constitutes a real depletion in the ozone layer is not aided by the fact that both daily and seasonal natural fluctuations in the ozone density over any given point are much larger than the long-term 5 to 10 per cent depletion which may cause significant climatic change and health effects.

While the debate about the effect of past atmospheric nuclear explosions continues, a much more serious problem would be posed if even a limited nuclear war were to occur. Indeed, Hampson has warned of the danger of major disruption of the ozone layer after a nuclear conflict. Such a disruption would, like radioactive fallout, tend to spread a nuclear war's destructiveness well beyond the areas actually damaged by blast effects. Hampson has suggested that a nuclear conflict should be considered "photochemical war on the atmosphere" and

as such is a proper topic for future talks on arms limitations. Fred C. Ikle, Director of the U.S. Arms Control and Disarmament Agency, has recently echoed Hampson's concern and listed possible ozone depletion as one of six unanticipated nuclear weapons effects.

Ozone and Chlorine

While it may not be surprising that a violent activity such as nuclear warfare threatens the ozone layer, it is a shock to many people that the relatively peaceful activity of spraying on an underarm deodorant could do the same. This possibility arises because the man-made "Freon" gases (predominantly $CFCl_3$ and CF_2Cl_2) widely used as aerosol propellents and working fluids in air conditioners and refrigerators can diffuse into the stratosphere, where they undergo photodissociation or other reaction to release atomic chlorine. Other man-made chlorinated hydrocarbons such as CCl_4 (carbon tetrachloride), $CHCl_3$ (chloroform), CH_3Cl (methylchloride), and more complex chlorinated hydrocarbons may also be sources of stratospheric chlorine. However, to date, most studies have centered on $CFCl_3$ and CF_2Cl_2 for several reasons: their production rate is high and growing fast (0.3 and 0.5 million tons, respectively, in 1972, with an annual growth rate of roughly 10 per cent); there are no known significant tropospheric sinks for these compounds — they do not react in air, are insoluble in rain water, are not absorbed by the oceans or soils, and do not photolyze in visible or near-ultraviolet light; they are completely man-made with no known natural sources such as those hypothesized for CCL_4 and $CHCl_3$; and they are utilized in ways that guarantee their release into the atmosphere. These factors insure a buildup of Freon in the troposphere, and eventual large-scale diffusion into the stratosphere. Indeed, measurements of $CFCl_3$ and CF_2Cl_2 indicate that they are now widely dispersed throughout the troposphere at levels of roughly 0.1 parts per billion.

Once in the stratosphere, both $CFCl_3$ and CF_2Cl_2 can be broken down by ultraviolet photons or may react with $O(^1D)$ and other highly reactive atmospheric constituents to release atomic chlorine. The consequences for stratospheric ozone were first studied because hydrogen chloride, HCl, is an abundant exhaust product from rocket engines such as those of the Minuteman missile fleet or those proposed by N.A.S.A. for the space shuttle booster. It was feared that atomic chlorine would be released from HCl by photolysis:

$$HCl + h\nu \rightarrow H + Cl \qquad (19)$$

or by reaction with OH:

$$OH + HCl \rightarrow H_2O + Cl \qquad (20)$$

Once free, atomic chlorine can catalyze an ozone destruction cycle similar to but apparently even faster than NO reactions 14 and 16. Here, the reactions are:

$$Cl + O_3 \rightarrow ClO + O_2 \qquad (21)$$

$$ClO + O \rightarrow Cl + O_2 \qquad (22)$$

Their result, like that of reactions 14 and 16, is the conversion of one O_3 and one O into two O_2. The chlorine atom regenerated in reaction 21 is free to continue the ozone destruction cycle unless it reacts with some atmospheric species before it reacts with another O_3. The most likely chain-breaking reactions are thought to be:

$$Cl + HO_2 \rightarrow HCl + O_2 \qquad (23)$$

and

$$Cl + CH_4 \rightarrow HCl + CH_3 \qquad (24)$$

which form HCl. Of course, this HCl will eventually release chlorine via reactions 19 or 20 unless it is transported out of the stratosphere or otherwise neutralized. No efficient neutralization processes are now known for HCl, but interaction with stratospheric aerosol particles may be important.

Model atmospheric calculations involving chlorine reactions 19 through 24 with currently available rate constants indicate that the HCl from currently projected rocket and missile operations is not a serious threat to the ozone layer. However, atomic chlorine released by $CFCl_3$ and CF_2Cl_2 is a very serious threat unless atmospheric release of these compounds is somehow curtailed within the next few years. Without these reductions, present calculations indicate that serious ozone depletion may occur by 1990. Typical values for the magnitude of this decrease as calculated by McElroy and co-workers are shown on page 45, which suggests one significant aspect of the Freon problem: the long time constants involved. Since current estimates of the average atmospheric lifetime for $CFCl_3$ and CF_2Cl_2 are 45 and 68 years respectively, Freon released today will be around to cause mischief well after most of us are gone.

The credit for publishing the danger to the ozone layer

of atmospheric Freon goes to M. J. Molina and R. S. Rowland of the University of California, who issued their initial warnings in early 1974. This source of stratospheric chlorine was identified privately by this author in 1973 to N.A.S.A. officials concerned with pollution from the space shuttle. Molina and Rowland's work on Freon has stimulated a great deal of current research on the atmospheric chemistry of these species, part of it sponsored by the Manufacturing Chemists Association, whose corporate members, particularly duPont, are faced with severe economic losses if Freon use must be curtailed. Congressional subcommittee hearings and news media coverage of the Freon problem have also led to the filing of several "anti-Freon" bills by members of the 94th Congress. In addition, a task force representing several federal agencies has recommended that the use of Freon in aerosol spray cans and refrigeration units be severely curtailed or modified if current Freon-impact predictions are verified by a National Academy of Sciences report due next year. A scientific, economic, and political fight seems to be heating up over what would normally be an obscure topic in atmospheric chemistry.

As a final note on chlorine, it seems reasonable to assume that nuclear explosion over, in, or near the oceans will evaporate large quantities of sea water, including chlorine-containing salts. The chlorine injected into the atmosphere in this manner should be carefully evaluated to determine how its effect on the stratospheric ozone layer compares with bomb-produced nitrogen oxides.

Other Ozone Eating Chemicals

It seems quite likely that new chemicals will be added to the list of species that could threaten the stratospheric ozone layer. Likely candidates whose chemistry has not yet been fully explored include alkali metals such as atomic sodium and potassium (possibly injected by nuclear explosions over oceans); sulfur oxides, SO and SO_2 (which may mimic NO and NO_2); and the heavier halogen species, bromine and iodine, which may behave much like chlorine. McElroy and co-workers have performed calculations suggesting that stratospheric pollution by bromine-containing compounds is potentially more serious than chlorine additions. Potential bromine-containing pollutants include compounds such as methybromide and ethylenedibromide, which are currently used as gasoline additives; agricultural fumigants; and flame-retardant additives in plastics and textiles. Natural and man-made sources of these and other chemicals must be evaluated in order to determine their role in the inadvertant modification of the ozone layer.

In addition, the recent focus on the chemical fragility of the ozone layer may lead to the development of stratospheric chemical weapons that burn local, temporary holes in the ozone layer above strategic enemy resources, particularly at higher latitudes where local ozone production rates are slow. If such weapons prove feasible, it can only be hoped that they are quickly added to the list of chemical weapons proscribed by the 1925 Geneva Convention on Chemical Warfare, recently ratified by this country.

Suggested Readings

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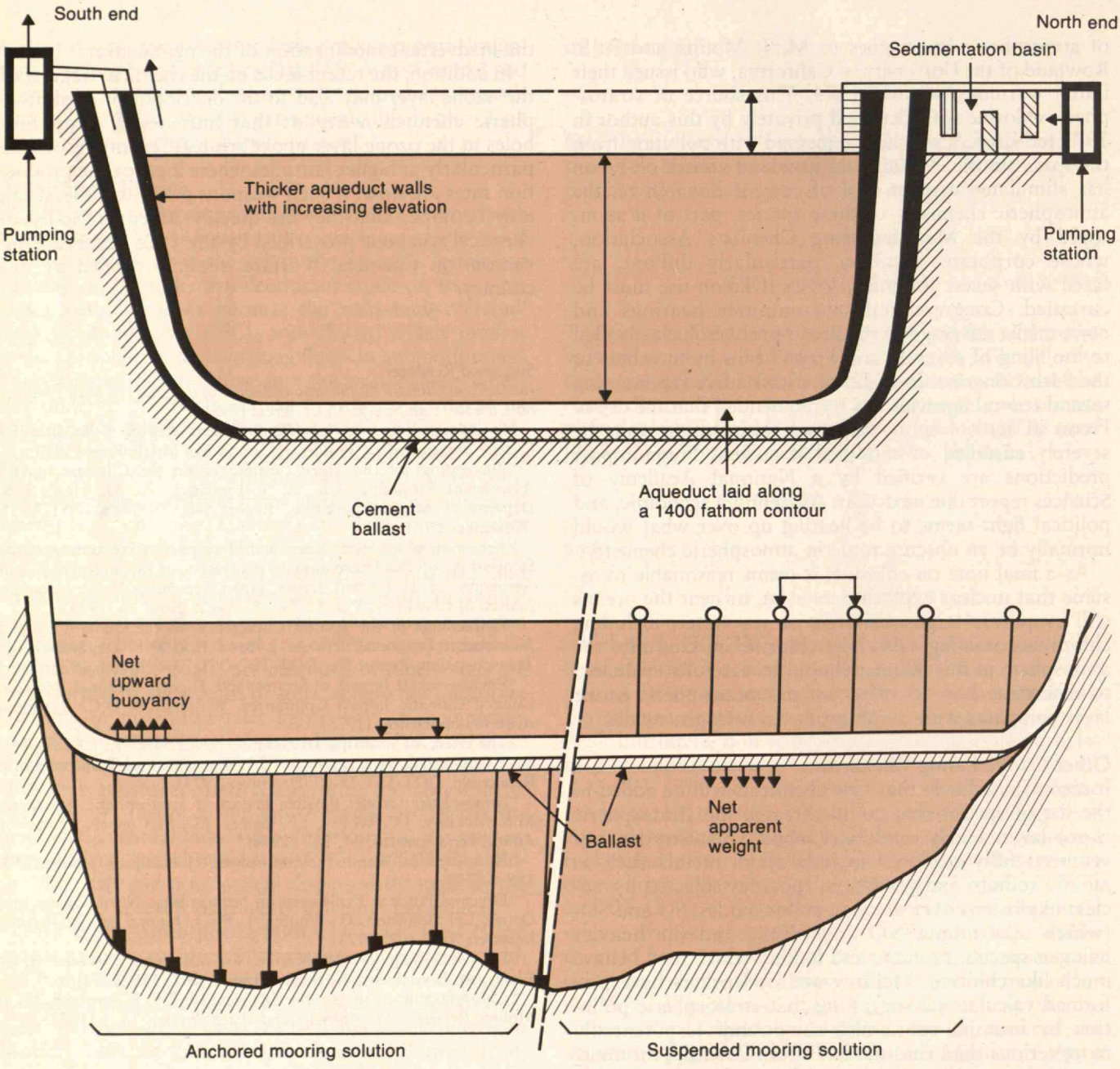
Charles E. Kolb received his S.B. in chemistry from M.I.T. and his Ph.D. in physical chemistry from Princeton. He is currently Senior Research Scientist at Aerodyne Research, Inc., where he has conducted research on gas-phase lasers, atmospheric and combustion chemistry, and on atmospheric interactions with rocket-exhaust plumes, re-entry vehicle wakes, and rocket-borne chemical releases.

The increase in oil prices has made it at least thinkable to duct Rhone River water from France to North Africa. The possibilities and the costs are here examined.



Three schemes for an aqueduct to carry water from the Rhone estuary to drought-stricken North Africa in exchange for fossil fuels. The top drawing shows an aqueduct laid along a 1,400-fathom contour line across the Mediterranean. A sedimentation basin is shown at the northern end to collect suspended particles that would otherwise clog the flow. The walls of the aqueduct taper with depth for economy in construction; at increasing depth the pressure of the sea tends toward equaling the pressure within the aqueduct. The bottom drawing shows two possibilities for suspension: At the left, the aqueduct is ballasted so as to be somewhat buoyant and restrained from below; at the right, it has an apparent weight and is restrained from above. As explained in the text, the sea-bottom solution appears preferable.

Joseph G. Debanne
University of Ottawa

Proposal for a Trans-Mediterranean Aqueduct

If they prove to be technically feasible and economical, marine aqueducts could connect the estuaries of large rivers to the dry regions of the world, providing these regions with plentiful water supply for agriculture and industry. It is here intended to explore the feasibility and economics of ducting the equivalent of an average river (by North American standards) across the Mediterranean Sea, from the estuary of the Rhone River to the coast of North Africa where fresh water is needed.

The idea occurred to the author in 1971, after a visit to Tunisia while compiling an input-output matrix of the Tunisian economy. At the time, Tunisia did not have the financial resources for such an undertaking and was not likely to obtain it. However, the idea — and the research project here proposed — would also be applicable to other areas, such as the ducting of the Tigris River to Kuwait. The Congo and Niger could be ducted northward to the Mauritanian coast, the Indus could be ducted north-westward to the Pakistani and Iranian coasts on the sea of Oman, and the Columbia could be ducted to southern California.

For illustrative purposes, two flow rates, 20,000 and 40,000 cubic feet per second (c.f.s.) are considered. Such rates are comparable to the average throughputs of the Hudson River (21,500 c.f.s.) and the Susquehanna River (38,000 c.f.s.) respectively and would provide sufficient water from the Rhone River in France to irrigate 4.5 and 9 million hectares respectively in Algeria and Tunisia.

A 150-foot diameter aqueduct, 500 miles long, made of rubber or rubber-like plastic is placed on the sea bottom at an average depth of 1,400 fathoms (8,400 feet). It connects the estuary of the Rhone to the Algerian coast. The aqueduct is maintained in place by a cement ballast to overcome the buoyancy of fresh water. A head of 298 feet of water at the upstream end is sufficient to maintain the aqueduct in shape and to maintain flow at 20,000 c.f.s.; it must be increased to 306 feet for the 40,000 c.f.s. case. Most of this head is recoverable at the downstream end and is usable as hydraulic energy. It therefore represents an export of energy at the upstream end of the aqueduct equal to 580 trillion B.t.u.s per year in the 20,000 c.f.s. case and 1,190 trillion B.t.u.s per year in the 40,000 c.f.s. case. Accordingly, the trans-Mediterranean aqueduct operation should be accompanied by an "energy swap" whereby France would receive some 100 million barrels of oil per year (or its energy equivalent in natural gas) and Algeria and Tunisia would correspondingly reduce their consumption of oil and natural gas. The energy swap would be profitable to both countries because directly using a hydraulic head is more efficient than generating this hydraulic energy with pumps powered by internal combustion engines or thermal power plants. The energy savings would be on the order of 200 million barrels of oil or 1,156 billion cubic feet of natural gas per year in the 40,000 c.f.s. case.

The total cost of the aqueduct is estimated at $6.8 billion in the 20,000 c.f.s. case and $8.3 billion in the 40,000 c.f.s. case. The delivered cost of the water is 5.75 and 3.5 cents per cubic meter respectively, compared to 20 cents per cubic meter for desalinated water. Energy consumption is 8.5 and 34 B.t.u.s per cubic foot. Either figure compares quite favorably with the 6,000 B.t.u. energy consumption for a cubic foot of desalinated water. Potentially about 25 B.t.u.s per cubic foot of aqueduct water would be reclaimed in the form of electromechanical energy originating from the sea. This would compensate for a good portion of the energy used to move water through the aqueduct. Alternately, some 1,000 B.t.u.s of refrigeration energy per cubic foot of water would be available at the downstream end of the aqueduct for cooling purposes.

The Physical Constraints

If the pressure drops due to friction flow in an aqueduct were on the same order as in conventional pipelines (between 5 and 30 p.s.i. per mile), the power needed to move 20,000 c.f.s. of fresh water with a pressure drop of 10 p.s.i. per mile would be on the order of 1,474 megawatts per mile. Over a distance of some 500 aqueduct miles across the Mediterranean, the total power required would be enormous: 737,000 megawatts. This represents an energy consumption of 37 megajoules per cubic foot of transported water, which is five times more than the energy needed to desalinate water. One is led to seek an aqueduct diameter that would considerably reduce the pressure drop to a very small value, between 1 and 2 p.s.i. over the entire 500 miles. For a pressure drop of 1.22 p.s.i., this diameter would be 150 feet, much larger than that of any aqueduct ever built. Still, it is a typical dimension for some of the inflatable plastic structures commonly constructed for gymnasiums and sports arenas. It would therefore appear reasonable to think in terms of an inflatable plastic or rubber structure, with appropriate mechanical properties and high resistance to bacterial attack and other forms of deterioration beneath the sea. It would be maintained in shape by internal pressure and it would be held in place at a safe depth. It is also important to avoid an increase in the roughness of the

inner wall of the pipe because of organic growth. This would probably be accomplished routinely by using some chemical.

The power requirements to transmit 20,000 c.f.s. in a 150-foot diameter aqueduct with a minimal pressure drop of 1.22 psi over 500 miles of aqueduct is 180 megawatts, which corresponds to 9 kilojoules per cubic foot of water transported across the Mediterranean. This is 700 times more economical in energy requirements than production of water through desalination. If the flow rate were doubled to 40,000 c.f.s, the power consumption per cubic foot would be eight times larger, but still 89 times smaller than the power requirements for desalinated water.

Sedimentation effects. River water entrains sediments in the course of its downward flow to the sea. The velocity of the water decreases when the river cross-section widens, causing a deposition of these sediments. Such is the case in the Rhone estuary, where the river sheds relatively coarse particles. The increase in water velocity in the aqueduct would ensure entrainment of the finer sediments that would not have settled.

There are periods of the year, however, when water velocities at the estuary of the Rhone are sufficiently high to maintain in suspension relatively large quantitities and sizes of sediments. Some of these sediments may be entrained in a downward or horizontal trajectory of water flow. However, the aqueduct, unlike rivers, would have crests and valleys; in particular, water would have to rise some 8,400 feet at its southern end. Some of the sediments may be too heavy to reach the surface unless water velocities are sufficient.

This sedimentation problem will have to be studied in detail. Safe water velocities must be determined. It may prove necessary to build a sedimentation basin at the upstream end of the aqueduct. Accordingly, for every 10,000 c.f.s. of aqueduct capacity, $50 million is budgeted for the solution of sedimentation problems.

Buoyancy effects. At 12° C., the prevailing temperature in the lower depths of the Mediterranean, an aqueduct of 150 feet internal diameter would be subjected to a water buoyancy force of 38,600 pounds per linear foot of aqueduct. This water buoyancy is partly counterbalanced by the apparent weight of the aqueduct wall. Assuming a uniform wall thickness of reinforced rubber, the apparent weight of the aqueduct is 727 pounds per foot of aqueduct per inch of wall thickness. Hence the wall contributes relatively little to compensate for the buoyancy of fresh water in the sea, which is two orders of magnitude larger.

Bending moments and maximum mooring span. A one-mile span of aqueduct moored at both ends will be subjected to forces resulting from a buoyancy load distributed throughout the span. At each mooring point, 8.46×10^{10} foot-pounds of bending moment develops (a three inch wall thickness is assumed). Moreover, the stress at mid-section of the span is 133,000 p.s.i., which far exceeds the advertized tensile strength (6,400 p.s.i.) of Hytrel, duPont's toughest pneumatic tire material.

If an allowable tensile stress of 2,000 p.s.i. were assumed (adopting a modest safety factor of 3), the allowable bending moment would be 15.28×10^9 inch-pounds, and the maximum span between anchors would be 648 feet. It would clearly be uneconomical to anchor a 500-mile aqueduct every 648 feet, particularly if this aqueduct is to pass through deep water, which would be the case for the shortest distance from the estuary of the Rhone to North Africa. Perhaps a pipe could be anchored every mile, and reinforced in those sections where the bending moment is too high. This solution, certainly much less expensive to construct, would still represent quite a challenge because of the difficulty of the underwater engineering work.

Sea current effects. In order to assess the effect of sea currents on a 150-foot diameter pipe, assumptions must be made about the velocity of the current and the length of the mooring span. If the aqueduct is securely moored at one-mile intervals, and subjected to a sea current of 12 feet per second (or 7.1 knots, which is here considered as an upper limit for current velocities in the eastern Mediterranean), then the kinetic energy of the current would be transformed into a bending moment of 5×10^{10} foot-pounds. The corresponding stress is 78,522 p.s.i., which is far beyond the range of applicability of a material with a rating of 6,400 p.s.i.

Considering that a straight line north-south pipe would be moored mostly at great depths ranging from 1,200 to over 1,500 fathoms, the mooring solution appears at the outset very expensive, even if the aqueduct were reinforced to allow spans of one mile. In the light of the cursory analysis in this section, it appears that a possible solution for a trans-Mediterranean aqueduct would be to uniformly ballast the aqueduct and place it on the sea floor.

Magnitude of aqueduct deflection. The maximum deflection of the aqueduct is found by considering the worst load condition — that is to say, the one in which the water buoyancy force and the sea current drag force combine at a straight angle. The result is a uniform load of 42,410 pounds per linear foot of aqueduct. Over a span of 648 feet, this produces a deflection of 8 inches, or exactly one-thousandth of the span length. Unfortunately, as we pointed out, the cost of mooring the aqueduct every 648 feet may very well be economically unbearable. On the other hand, if we use a reinforced pipe anchored every mile, classical deformation theory predicts a deflection of about 3,000 feet. If this calculation were off by 100 per cent, the magnitude of the deflection would still make a one-mile mooring span technically unfeasible. However, since the magnitude of the deflection varies with the fourth power of the mooring span length, a reduction of this length by a factor of 2 implies a deflection 16 times smaller, so a compromise might be found between an acceptable deflection and an acceptable construction cost.

Hydrostatic pressure differential effects. There is a difference in hydrostatic pressure outside and inside the aqueduct due to the difference in density between fresh water and sea water. This difference would have to be corrected by an internal pressure in the aqueduct, to avoid deformation or collapse. The pressure differential is a linear function of depth. Accordingly, to avoid collapse of the fresh-water-filled aqueduct at its deepest sub-sea elevation, it would be necessary to maintain at all times in the aqueduct a head pressure at sea level equal to or exceeding the maximum hydrostatic pressure differential once the aqueduct is filled with fresh water. Moreover, the aqueduct ought perhaps to be equipped with pressure-relief valves that would equalize the pressures inside and outside the aqueduct if the inside pressure tended to drop below the outside pressure. Should these valves open, injection of some salt water into the fresh water stream would result. Considering the large diameter and throughput of the aqueduct, the relatively small amounts of salt water occasionally needed to prevent collapse of the pipeline are not expected to materially affect the quality of the irrigation water.

The Technical Options

At what depth would the aqueduct be positioned? It could be placed relatively close to the surface at a depth safe from surface maritime traffic and wave action. Alternatively, it could be placed on the sea floor with additional ballastso as to resist the thrust of sea currents. If the aqueduct were positioned on or near the sea floor along a north-south course across the Mediterranean, it would reach depths of 1,600 fathoms in its southern section and would generally lay at depths of 1,200 fathoms or more. Assuming that 1,400 fathoms is the maximum depth of the aqueduct, it would be necessary to maintain the north and south sea-level outcroppings of the aqueduct at a pressure of at least 127.7 p.s.i. In addition, a flow differential of a few p.s.i. would have to be superimposed at the northern end, thus requiring a total pressure of about 130 p.s.i. at the northern end for a flow rate of 20,000 c.f.s.

This would require very thick aqueduct walls or reinforcement at the sea-level outcrops and proportionately less thickness at deeper subsea levels. A pressure differential of 130 p.s.i. would require a wall thickness of 58.5 inches of rubber. Rubber or plastic pipe with that thickness has never been constructed before and appears to be a very expensive way to reinforce the two rising ends of the aqueduct. Reinforcement with a steel mesh, somewhat like in radial tires, may well prove to be a considerably more economical solution. However, for purposes of estimating the cost of the aqueduct, the unreinforced rubber wall solution was assumed as it leads to higher, and hence more prudent, cost estimates. It should be noted here that the maximum thickness of five feet would be at sea level and that the two rising ends of the aqueduct would have a wall thickness that tapered down to three inches at 1,400 fathoms. Therefore most of the aqueduct would have a wall thickness of three inches.

While material costs may be kept to a minimum, power costs at the northern end would be substantial. A pressure head of 130 instead of 1.22 p.s.i. would increase pumping power requirements at the head of the aqueduct by two orders of magnitude, from 180 to 19,180 megawatts, or 0.96 megajoules per cubic foot of fresh water. Still, this power consumption is almost seven times smaller per unit volume of fresh water than needed in the desalination process. Furthermore, some 128 p.s.i., or 98 per cent of the energy outlay at the northern head of the aqueduct, is recoverable at the southern end; the discharge pressure at sea level will be equal to the head pressure at the north end less the pressure drop due to the flow of water.

In other words, part of the pumping power required to move the fresh water from sea level to inland areas in Algeria would be generated at the upstream end of the aqueduct, in southern France, and recovered in North Af-

	Aqueduct capacity (cubic feet per second) 10,000	20,000	30,000	40,000	50,000	60,000	70,000	Unit costs
Rubber-plastic to withstand hydrostatic pressure ($10^6)	5310	5310	5310	5310	5310	5310	5310	$9/ft³
Rubber-plastic to withstand flow pressure ($10^6)	64	256	575	1022	1597	2300	3131	$9/ft³
Ballast ($10^6)	850	850	850	850	850	850	850	$12.5/yd³
Pumping power ($10^6)	9	72	243	576	1125	1944	3087	$400/kW
Sedimentation basin ($10^6)	50	100	150	200	250	300	350	$50×10⁶/10,000 m³
Construction costs ($10^6)	237	262	305	365	443	538	648	$142,000/day/inch
Total ($10^6)	6520	6850	7433	8323	9575	11242	13376	
Cost of water (¢/m³)	10.95	5.75	4.16	3.50	3.22	3.15	3.21	15%/yr. of capital investment
Cost per unit capacity (m³/s)	23.03	12.10	8.75	7.35	6.76	6.62	6.75	
Cost of power (¢/m³)	0.02	0.089	0.199	0.354	0.553	0.800	1.08	1¢/kWh
Power consumption (B.t.u./m³)	68.16	305.36	675.56	1207.42	1883.70	2729.14	3684.41	

Left table: The cost of a trans-Mediterranean aqueduct on the sea bottom is estimated. At the bottom of the table, the power consumption and the cost per cubic meter of water pumped are also shown. The latter is conservatively estimated by the use of a rule of thumb for natural gas pipelines, which are far more capital-intensive. Still, the cost compares very favorably with the cost of desalinating water.
Right table: A similar calculation is presented for a pilot project — an aqueduct 15 feet in diameter. The aqueduct considered in the text and in the top table would be 150 feet in diameter, to carry an adequate flow of water without having friction make the pumping pressure prohibitively large.

rica with practically no loss. This would represent half of a major international energy swap. The swap concept could be made more interesting to both parties if the Rhone and possibly the Isere were tapped at an altitude of 300 feet above sea level. In this manner, a discharge pressure of 128 p.s.i. at sea level would be attained, and 168 billion kilowatt-hours per year of currently unreclaimed French hydraulic energy would be transmitted via the aqueduct to Algeria. France would get in return an agreed-upon annual volume of Algerian oil or gas which could possibly be transmitted via a large diameter, flexible submarine pipeline attached to the flexible water aqueduct. In this manner, both countries would have a vital interest in the trans-Mediterranean transmission project.

One source of power which could be a by-product of the deep-water aqueduct solution is thermal power from the Mediterranean. After its journey at a depth of 1,400 fathoms, the fresh water transported in the aqueduct would be at 12° C, the prevailing temperature of deep waters in the Mediterranean. This large supply of cold fresh water could be used as the cold source in large electric generation projects (either existing or to be built) and would increase the thermodynamic efficiency of such plants by approximately one per cent. Moreover, if solar energy were eventually tapped in North Africa to heat water on a large scale, it may become interesting to generate electrical power using solar-heated water at say 90° C as the hot source and aqueduct water at 12° C as the cold source.

One final advantage of the deep-water aqueduct is that it would not interfere with the fishing industry, and would not be subjected to the hazards to which pipelines and cables are exposed in shallow waters. The shallow sections of the aqueduct at its northern and southern ends would be in territorial waters that the governments involved would take adequate steps to protect.

The major disadvantage of the deep-water aqueduct is that repairs would be difficult and expensive at 1,400 fathoms. However, mini-submarines are presently available for operations at depths of 6,000 feet; they could be strengthened for operation at 8,400 feet, and used for aqueduct maintenance.

Having considered the deep-water solution, it is now in order to consider the feasibility, advantages, and disadvantages of a shallow-water aqueduct. One main advantage is that reducing the depth of the aqueduct reduces the hydrostatic pressure differentials. Moreover, accessibility at shallow depths would considerably facilitate repairs and maintenance work.

The shallow-water solution would consist of placing the aqueduct at depths in the neighborhood of 300 feet, and on the sea floor where possible. This would considerably lengthen the aqueduct route, which would now bear eastward from the Rhone estuary along the French and Italian Rivieras, then take a southerly course to the west of Corsica and Sardinia and reach the African coast in eastern Algeria, near the Tunisian border. The length of this aqueduct would be close to 800 miles, most of it resting on the sea floor. In this case, an internal aqueduct

	Aqueduct capacity (cubic feet per second) 2.23	4.46	6.69	8.92	11.15	13.38	15.61	Unit costs
Rubber-plastic to withstand hydrostatic pressure ($10^6)	531.00	531.00	531.00	531.00	531.00	531.00	531.00	$9/ft³
Rubber-plastic to withstand flow pressure ($10^6)	6.4	25.60	57.50	102.20	159.70	230.00	313.10	$9/ft³
Ballast ($10^6)	8.5	8.5	8.5	8.5	8.5	8.5	8.5	$12.5/yd³
Pumping power ($10^6)	0.71	5.67	19.13	45.35	88.58	153.07	243.07	$400/kW
Sedimentation basin ($10^6)	0.394	0.79	1.18	1.57	1.97	2.36	2.76	$50×10^6/10,000 m³
Construction costs ($10^6)	23.7	26.2	30.5	36.5	44.3	53.8	64.8	$142,000/day/inch
Total ($10^6)	570.70	597.76	647.81	725.12	834.05	978.73	1163.23	
Cost of water (¢/m³)	121.67	63.72	46.03	38.65	35.56	34.77	35.43	
Cost per unit capacity (m³/s)	7.25	3.80	2.74	2.30	2.12	2.07	2.11	
Cost of power (¢/m³)	0.22	0.88	1.98	3.53	5.52	7.94	10.80	
Power consumption (B.t.u./m³)	21.25	85.01	191.27	340.01	533.23	767.00	1043.28	

pressure of at least 4.6 p.s.i. would be needed to counteract the hydrostatic pressure differential at 300 feet. The pressure at sea level on the upstream end of the aqueduct would then be 6.6 p.s.i., where 2 p.s.i. is the estimated head needed for a flow of 20,000 c.f.s. A wall thickness of 3 inches would suffice to withstand such pressure, with a one-inch thickness or less at the upstream end of the "horizontal" section.

If the flow rate were doubled to 40,000 c.f.s., the total head required at the upstream end would be 12.4 p.s.i. The required wall thickness would be 5.6 inches of rubber at sea level and 2.2 inches at the 300 foot depth, with a maximum of 3.5 inches at the upstream end of the "horizontal" section.

The Economics of a Trans-Mediterranean Aqueduct

A cost estimate of the aqueduct will here be made on the basis of rough estimates of the materials needed for the project, and the installed power needed to move the water. The construction cost depends on the technology available or developed for this type of project. Accordingly, the construction cost would be highly dependent on the solutions devised. Pumping down a cement slurry to construct and place the ballast, for example, would reduce installation cost of the ballasting by a factor of 10 to 50. Likewise, the use of a flexible, inflatable aqueduct wall material should considerably reduce the problems and costs associated with the installation of the aqueduct.

Rubber-plastic. A 500-mile aqueduct with a 150-foot diameter would require 104 million cubic feet of rubber-plastic per inch of wall thickness, at a cost of $936 million per inch of thickness over the entire pipeline, assuming a unit cost of $9 per cubic foot. In round numbers, this is $1.9 million per inch-mile in 1974 dollars.

The wall thickness or equivalent reinforcement depends on the pressure differential to which the aqueduct wall is subjected, which can in turn be subdivided into two parts. First is the hydrostatic head necessary to counterbalance the maximum depth below sea level at which the aqueduct is laid. This head is maximum at sea level, where the pressure differential necessary to prevent collapse of the aqueduct at 8,400 feet is 127.7 p.s.i. This differential decreases linearly with depth and vanishes at 8,400 feet. Accordingly, the average pressure differential throughout the aqueduct's rising sections is half the maximum pressure, 63.8 p.s.i., requiring an average rubber-plastic wall thickness of 29 inches. Assuming that the lengths of the north and south rising sections are respectively 50 and 5 miles, the additional rubber requirements for these sections would be 334 million cubic feet of rubber-plastic.

It is furthermore assumed here that the "horizontal" section of the aqueduct would be laid as much as possible in a straight line, doubtless resulting in crests and valleys along the course. If the aqueduct depth is allowed to vary between 8,000 and 8,400 feet, depending on sea-bottom topography, the crests of the aqueduct would be subjected to a hydrostatic pressure differential of 6.1 p.s.i., thus requiring a wall thickness of 2.7 inches, which will be considered here as the minimum wall thickness of the aqueduct. A 2.7 inch wall thickness over 450 miles of aqueduct represents 256 million cubic feet of rubber-plastic. This volume, plus the 334 million cubic feet needed for the north and south rising sections, amounts to 590 million cubic feet of rubber-plastic needed to cope with hydrostatic pressure differential effects.

The second component of the total pressure is needed to maintain flow at the desired rate. It was estimated earlier that a flow rate of 20,000 c.f.s. induces a cumulative pressure drop of 1.22 p.s.i. for 500 miles of pipeline. Furthermore, every p.s.i. of pressure differential across the walls of the aqueduct requires 0.45 inches of additional wall thickness. This would correspond to an aver-

age quarter-inch of additional rubber thickness per p.s.i. pressure drop, since the drop is uniformly distributed along the length of the aqueduct. For a flow rate of 40,000 c.f.s., the volume of rubber-plastic needed for the aqueduct would be 590 million cubic feet to withstand the hydrostatic differential, and 114 million cubic feet to withstand the pressure of flow. The total is 704 million cubic feet of rubber-plastic. (This could be reduced by a factor of two to four by steel belting or other reinforcement.) If the aqueduct were to be constructed in two years, or 730 days, this would require a rubber-plastic production capacity of 964,000 cubic feet, or 80 million pounds, per day — a capacity that would require supply from various plants, and possibly the construction of new petro-chemical plant capacity.

Power. The requirements are of two types: (1) Power used to overcome the pressure drop due to flow of water through the aqueduct. This power cannot be recovered and is squarely assignable to the cost of moving water across the Mediterranean. (2) Power used to raise the hydrostatic pressure in the aqueduct so that it remains equal to or higher than the hydrostatic pressure of the sea at the deepest level reached by the aqueduct. This power is fully recoverable at the southern end, where it can be directly used to move water to inland locations. Accordingly, it ought not to be included in the cost of the irrigation infrastructure.

The power can be expressed as a function of the flow rate through the aqueduct. The cost of installed pumping power is here assumed to be $400 per installed kilowatt.

Ballasting. A uniformly distributed ballast could be in the form of a steel coil or armature around the rubber aqueduct; or it could be made of concrete or sea-bottom sediments or some other inexpensive material. Ballasting a 500-mile aqueduct with steel would require 51 million tons of steel. At a unit cost of $350 per ton, this would cost approximately $17.8 billion, which is prohibitively expensive. Ballasting with concrete would require 76.6 million tons, or 41.7 million cubic yards, of concrete (the weight is different for concrete because volume enters into the calculation). At a cost of $12 per cubic yard, this amounts to $500 million. Accordingly, it is here assumed that the aqueduct is ballasted with concrete. An interesting possibility would be to use current oil-well cementing technology. A cement slurry would be pumped down from the surface into inflatable ballast forms on the sea floor. In order to securely maintain the aqueduct in place, additional quantitites of cement would be needed; $850 million may be a sufficient overall expenditure on concrete if cheaper pouzzolanic or perlitic cements are used.

Construction. This cost is considerably harder to estimate. The construction and installation will take place at sea, using a specially designed aqueduct-manufacturing-and-laying ship. Several vessels would be needed for supply, logistics, and pipe positioning, and it is estimated here that this operation would cost $500,000 a day, which would amount to $365 million over a two-year period.

The calculated cost of the aqueduct is presented in the table on page 52, for flow rates ranging from 10,000 to 70,000 c.f.s The table indicates an optimum flow rate around 50,000 c.f.s, and an economical range of throughputs between 40,000 and 70,000 c.f.s. However, power consumption increases rapidly with the flow rate, and 40,000 c.f.s. appears to offer a definite advantage in this respect.

In order to estimate the unit cost of service, an approximation used in North America for gas and oil pipelines was adapted. This rule of thumb estimates the total cost of service for a regulated natural-gas pipeline at approximately 18 per cent per year of the total capital investment in the pipeline. The estimate reflects operating costs, which are very high in the case of a gas pipeline with a compressor station every twenty miles. Moreover, the estimate includes rate of return on the rate base, in addition to interest payments on the debt of the corporation. Since no rate of return is to be applied to this project, which is essentially part of the national infrastructure, 8 per cent is subtracted from the 18 per cent. Considering, however, that unforeseen operating costs and tariffs may apply, 5 per cent is added, thus bringing the annual cost of service to 15 per cent of the project's total cost. The unit cost per cubic meter of water is obtained by dividing this number by the annual throughput of the aqueduct. The 40,000-c.f.s. case, for example, entails a unit cost of 3.5 cents per cubic meter. This compares quite favorably with water desalination where the current cost is 20 cents per cubic meter.

The cost study presented in this section and in the table deals with the 1,400-fathom aqueduct; no figures have been presented for the 50-fathom aqueduct. These can easily be calculated, keeping in mind that the length of the aqueduct would be about 800 to 850 miles instead of 500. This would tend to increase the flowing pressures necessary to achieve a desired flow rate, and increase the total quantities of materials as well as certain construction costs. The economy realized by reducing the hydrostatic pressure differential is really an illusory one, since that power is recoverable, and could be used to move the water from sea level to the higher altitudes of the Algerian or Tunisian interiors.

The Climate for an Aqueduct

Not since Roman times has the Mediterranean basin enjoyed the fruits of economic integration. Shortly after the scinding of the Roman empire by Constantine into East and West in the second century A.D., rivalries and confrontations developed between the eastern and western Mediterranean basins. They prevailed until the seventh century, when Islam swept the southern and eastern Mediterranean shores. This initiated a second series of confrontations which have dominated the history of the Mediterranean basin until very recently. Territorial encroachments were made by the south shore Arabs against the north shore, then by the north shore Crusaders against the eastern shores, then by the east shore Turks against the offshore islands and the north shore. After the nineteenth century the pattern of encroachments was reversed, with the north shore colonizing the southern and eastern shores. Now that the age of colonization is over and residual encroachments have disappeared in the western Mediterranean basin, this region has an opportunity to become a community of nations bound by economic complementarities and by immensely rich cultural, spiritual, and historical legacies.

A trans-Mediterranean aqueduct would no doubt create a mighty economic link between the north and south shores. It would also have a very high symbolic

value as an embodiment of reconciliation and friendship after twelve centuries of confrontation. The most serious problems are perhaps of a political and legal nature. A project of this type and magnitude implies a high degree of interdependency between the European and the North African economies. It also implies international acceptance of sea lanes reserved for aqueducts, where no fishing or mining would be allowed. All this would have been politically unacceptable a few years ago. Fortunately, there are now strong reasons to expect that the interdependency of the European and North African economies would be sought by all parties.

A marine aqueduct supplying hydraulic energy from France would no doubt be looked upon favorably by France and other contiguous countries such as Italy and Spain if the project does not materially jeopardize the quality of marine life and the ecology of the eastern Mediterranean. France would be receiving natural gas and oil in return for the hydraulic energy supplied to North Africa. This would be very attractive for France, which has discovered very little gas and oil on its soil. More important perhaps, the trans-Mediterranean aqueduct project would strengthen the economic and political ties that France has assiduously cultivated with the Arab world since Algerian independence in 1967. Such ties have become a necessity, not only for France, but for all oil-importing, technologically advanced countries of the Common Market.

It is therefore expected that the French government would be willing to give very long-term, if not perpetual, guarantees to the North African states regarding the supply of fresh water and hydraulic energy via the aqueduct. Such guarantees could be bolstered by a joint ownership of the aqueduct, which would render its operation at full capacity profitable to both parties. On the Algerian side, the commitment would be very large, running into tens of billions of dollars in irrigation infrastructure. Accordingly, the aqueduct would become the lifeline of Algeria's agricultural sector, and prolonged interruption of aqueduct water would be a national disaster. Adequate physical, political, and economic guarantees would have to be secured by the Algerian government in order to lower the risk of interruption to an acceptable level. One physical guarantee would be the development of a large water storage capacity in North Africa, provided that evaporation losses can be kept down.

As to the political and economic safeguards, some form of economic association with the Common Market countries could provide adequate guarantees covering the flow of water to the south and the flow of oil or natural gas to the north. Moreover, guaranteed markets for part of the agricultural products generated by this large-scale irrigation project would be secured in the Common Market countries in return for consumer-goods markets in North Africa. The main result of the 1974 oil crisis seems to be a dangerous deficit in the balance of payments of northshore Mediterranean countries that depend heavily upon imported oil. Therefore, a project which would substantially increase the market for consumer goods and for advanced technology in North Africa would be very opportune, considering the eagerness of the Common Market countries to tie their balance of payments. It is because of the interrelated nature of the present oil-dollars-food-water shortage that a "Mediterranean" solution to this shortage has excellent chances of receiving support from all concerned.

Indeed, four economic factors favor marine aqueducts, and the trans-Mediterranean aqueduct in particular. They are:

— The shortage of food supply in the world, and the expected aggravation of this food shortage.

— The severe drought presently afflicting southern Algeria, Tunisia, and Morocco, as well as the other countries wholly or partially situated in the Saharan subcontinent.

— The increased revenues and the abundance of capital in the petroleum-exporting countries.

— The increase of energy costs and the consequent drain of capital from the petroleum-importing European countries.

The sharp rise of agricultural prices since 1972 was triggered by poor harvests of rice in Asia, wheat in Russia, and fishmeal in Peru (fishmeal is widely used in livestock feed), coupled with the sustained drought in Africa's Saharan belt. Even if these events do not represent a persistent trend, as the return of the anchovies off the Peruvian coast in 1974 seems to indicate, the food shortage and the resulting high prices are expected to continue: increasing demand for food and feed grains is gradually but surely narrowing the margin between production and total supply. This situation has been further aggravated by the rising oil price, which has made fertilizers and artificial irrigation much more expensive. This in turn has discouraged farming in countries that must rely on fertilizers or irrigation for their agricultural production, thus putting more pressure on the world price of food.

Superimposed on the above economic and agricultural conditions are alarming climatological trends: the Sahara Desert is slowly encroaching northward.

All the above problems suggest a dim picture of the food situation a decade from now. The Mediterranean aqueduct may soon become an urgently needed technological remedy. Now that the price of oil has sufficiently increased to allow underdeveloped oil-exporting countries such as Algeria to accelerate their development, the marine aqueduct idea has become financially feasible. Successful implementation of this project would open up immense possibilities for agricultural development in regions of the world where water shortage has been a recurrent cause of famine throughout recorded history.

Joseph G. Debanne's education includes degrees in mechanical and industrial engineering, petroleum engineering, mathematics, and management sciences. His professional experience includes work as a production and field engineer and as a systems analyst. In 1973-74, he was a Visiting Professor in M.I.T.'s Department of Ocean Engineering; and he is currently Professor of Management Sciences at the University of Ottawa.

Gordon J. MacDonald
Environmental Studies Program
Dartmouth College

Weather Modification as a Weapon

After three years of dodging Senate inquiries, the Department of Defense, on March 20, 1974, presented a subcommittee of the Senate Committee on Foreign Relations with a briefing on the extensive rainmaking operations in Southeast Asia. The briefing was classified "Top Secret," but the hearing report was made public on May 19, 1974. In this way the American public officially learned for the first time that the United States had used a new and developing technology in an attempt to slow movement of North Vietnamese troops and supplies along the Ho Chi Minh Trail network. From March of 1967 until July of 1972 the Air Force had rained canisters of silver iodide into clouds, and these in turn were supposed to initiate an increase in rainfall.

The project, at various times code-named Popeye, Compatriot, and Intermediary, was the first known, deliberate use of weather modification as an offensive weapon of war. The application of a new and largely unknown technology with its potential for causing unpredictable changes in the environment raises a number of important international policy issues. Will military use of weather modification endanger future international cooperation in the field, or even imperil the historic tradition of the full exchange of meteorological data? Will the first use result in a new weapons race in the more general field of deliberate environmental change? What constraints on the development of new technologies should be agreed upon internationally to lessen the danger of the creation of wholly new weapons of war?

Rainmaking and Foreign Policy

Weather modification moved from the realm of magic to an applied science in July of 1946 when Vincent Schaefer, then at the General Electric Laboratories, discovered that dry ice could bring about nucleation of super-cooled water into ice. These laboratory studies were extended by Irvin Langmuir and Bernard Vonnegut, who discovered that silver iodide as well as dry ice acted as an effective agent in bringing about the transformation of super-cooled water into ice.

The laboratory work was soon supplemented by field observations. In November of 1946, Schaefer flew into a cloud over Pittsfield, Massachusetts, at an altitude of 40,000 feet and at a temperature of −20°C. After dispatching several pounds of dry ice into the clouds, Schaefer observied draperies of snow falling below the clouds. This was the first scientific demonstration that precipitation could be artificially induced from a cloud that would not otherwise have precipitated. Since these early experiments cloud seeding or rainmaking has had a turbulent scientific history.

Buoyed by the spectacular success of these early experiments, Langmuir launched a major project to use cloud seeding to alter weather on a continental scale by seeding clouds in New Mexico. Although Langmuir was an effective advocate for weather modification, atmospheric scientists remained skeptical. The public, conditioned by the success of technology in World War II, readily accepted the claims of Langmuir and his followers. Those who believed the claims could also see the rich rewards that could result if one were able to capitalize on the technology. Indeed, many did, and by the early 1950s an estimated 10 per cent of the land area of the United States was undergoing commercial seeding. But the atmospheric scientists remained skeptical and a variety of studies, particularly those by the U.S. Weather Bureau, dampened enthusiasm for rainmaking as rapidly as it had built up.

The foreign policy implications of bringing about changes in precipitation were recognized at an early stage in the development of this technology. However, it was not until the early 1960s that these implications were articulated at the highest level of government. In his Inaugural Address in January, 1961, President John F. Kennedy stated: "Together let us explore the stars, conquer the deserts, eradicate disease, tap the ocean depths, and encourage the arts in commerce." Jerome Wiesner, then President Kennedy's science advisor, was given the task of translating these lofty intentions into policy formulation. With respect to weather modification he consulted primarily with Thomas Malone, a well known meterologist and an active participant in international scientific affairs. Dr. Malone argued that institutionalizing weather modification at the international level would be necessary if this nascent technology were to be used for peaceful purposes and not as a weapon of war. President Kennedy further explored this theme in September, 1961, when he told the United Nations, "We shall further propose cooperative efforts between all nations in weather prediction, and eventually weather control." This was followed by a draft resolution presented to the United Nations by Ambassador Adlai Stevenson in De-

Modern man is certainly not the first to recognize the destructive power of the weather. The Greek god Zeus was father of the gods, but he was also the lord of the sky, wind, rain, thunder, lightning, and the tamer of the warring elements.

Weather has already been used in warfare, and almost certainly will be used again unless international agreements prevent it. This article covers the history and perilous political implications of weather weapons.

cember, 1961. The resolution included a recommendation to "advance the state of atmospheric science and technology so as to provide greater knowledge of basic physical forces affecting climate and the possibility of large-scale weather modification." A vote was taken and the resolution passed on December 20, 1961. The Soviet Union had become a co-sponsor of the resolution; later, however, the Soviets were to become the chief critics of the United States' rainmaking activities in Southeast Asia.

Out of this resolution grew an activity which continues today — the World Weather Watch. This program, designed to bring about a better understanding of the atmosphere and improved forecasting capabilities, has been widely acclaimed as a success. However, little progress has been made during the ensuing years with respect to international control of weather modification. Indeed, events in Southeast Asia cast a doubt on whether it will be possible to bring about the goals suggested by President Kennedy in the early 1960s.

Current State of Rainmaking Technology

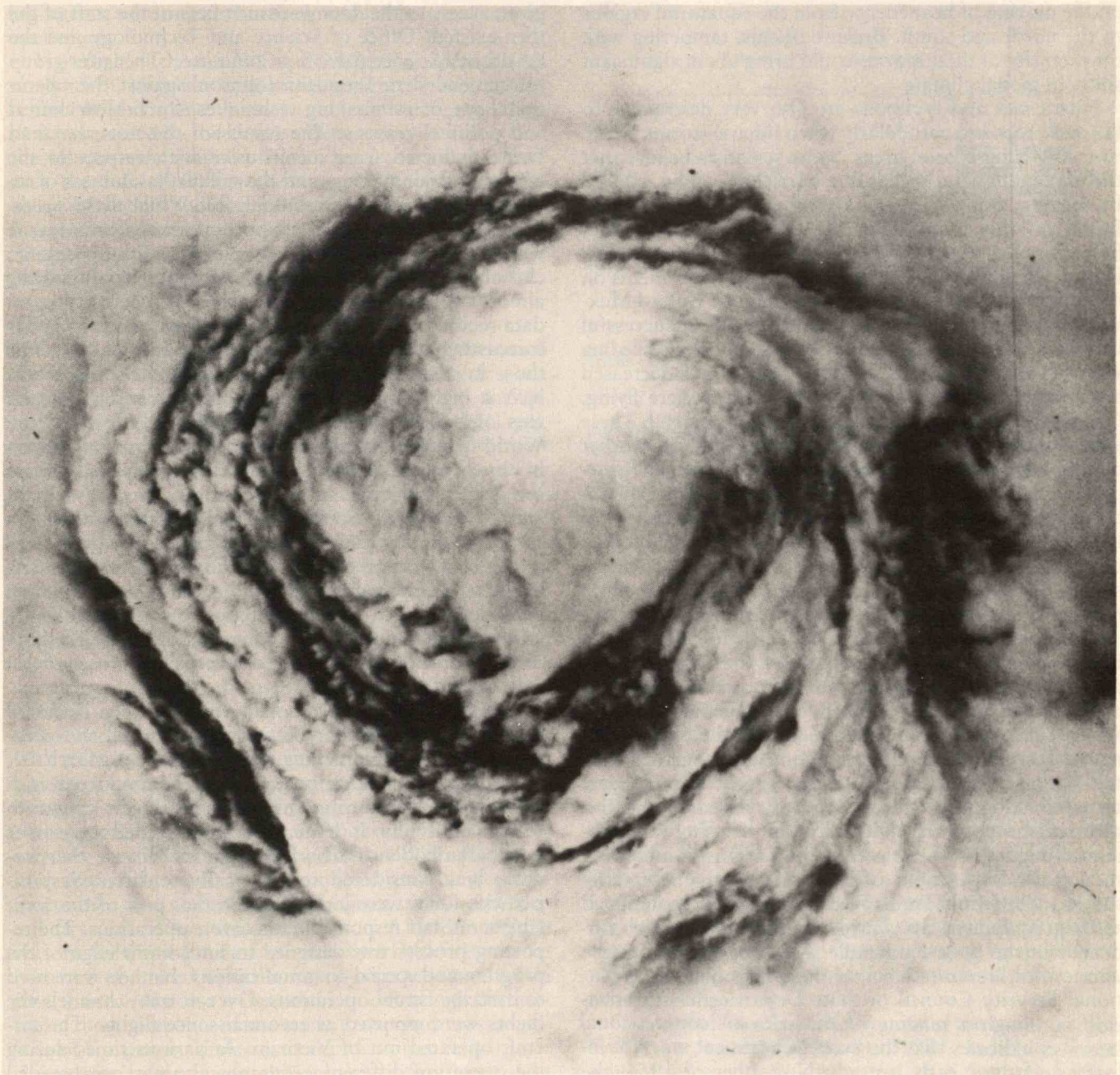
The scientific state of weather modification, like the situation with respect to international problems, is today somewhat confused. Most efforts to change weather have been directed towards learning to increase rainfall and snowfall. These efforts have been intensified by the growing demand for food and the restrictions placed on food production by scarcities of fresh water. Current work follows the early experiments of Schaefer and Vonnegut in which either dry ice or smoke of silver iodide is introduced into a cloud when the temperature is below freezing. The effect of the introduced material is to stimulate the formation of ice crystals. If the ice crystals grow sufficiently large, they can drop out of the cloud and reach the surface as snow or rain.

Today there is no real agreement among meteorologists about the efficacy of rainmaking, despite serious efforts at evaluating physical and statistical data. The principal problem is one of statistical verification. If a material such as dry ice is introduced into the cloud and it then rains or snows, one does not know whether the same rain or snow would have fallen without the introduction of the foreign material. Highly sophisticated techniques have been employed to separate induced effects from those that would have occurred naturally, but the results remain controversial. My own evaluation of the situation with respect to the possibility of rainmaking is similar to the position taken by two groups who evaluated weather modification under the National Academy of Sciences auspices in 1966 and 1973. In certain meteorological situations not completely understood, seeding can increase precipitation from 10 to 30 per cent over what would have been expected and over areas of hundreds of square kilometers. For example, 15 years of seeding has apparently significantly increased precipitation from extratropical cyclones passing over mountainous regions in California in winter. Based on these results and further experiments in the Rocky Mountains, the National Academy of Sciences study group in 1973 concluded, "Hence, in the longest randomized cloud-seeding research project in the United States involving cold or graphic winter clouds, it has been demonstrated that precipitation can be increased by substantial amounts and on a determinant basis."

The results of rainmaking on summertime convective clouds, the kinds associated with thunderstorms, have been most uncertain. Project Whitetop, conducted by the University of Chicago for a five-year period in the 1960s over 12,000 square miles, suggested that in primary seeding areas there was 30 to 40 per cent less rainfall on seeded days, and that the results were statistically significant. Scientists working for the National Oceanic and Atmospheric Administration have conducted extensive investigations on tropically conducted clouds in Florida. Statistically controlled experiments on single clouds have indicated that rainfalls from individual cumulus clouds apparently have been increased by large amounts, sometimes more than 100 per cent. The reasons why some experiments show positive results and others indicate a decrease in rainfall remain a mystery.

As far as the international ramifications of rainmaking are concerned, an important unresolved issue is that of how far downwind the effects persist. There is meager evidence that there are effects 200 to 300 kilometers downwind from the seeding regions, but whether precipitation is increased or decreased that far downwind is not known. Thus, today we do not know whether seeding near a nation's border will have an effect on its neighbors, although such effects are suspected.

Of potentially far greater international significance in rainmaking is the possibility of altering large storms, in particular, hurricanes and typhoons. The possibility of such alterations raises the spectre of guiding such storms for military purposes. However, the tropical storms play a crucial role in maintaining global climate. These storms are an essential element in transferring energy from the warmer tropical regions to the colder middle latitudes. Thus, the entire global heat balance and climate depend



The 1963 hurricane Beulah, shown here in an Air Force photograph taken at 60,000 feet, was one of the first hurricanes to be seeded in the modification program Project Stormfury — with encouraging results. Soon after seeding, the central pressure of the eye rose and the area of maximum winds moved away from the center. Project Stormfury raised the possibility that hurricanes could be modified by man, and that they could be used as weapons. (Photo courtesy National Oceanic and Atmospheric Administration)

Just as in the first precipitation experiments in the 1940s, smoke from silver iodide crystals is still the principal method of inducing rain or snow. This photograph is of 1973 experiments conducted as part of the National Hail Research Experiment by the National Center for Atmospheric Research. (Photo by Charles Semmer, courtesy of N.C.A.R.)

on the moving of heat energy from the equatorial regions to the north and south. Because of this, tampering with the intensity of these storms could bring about significant shifts in global climate.

Hurricanes and typhoons are also very destructive to life and property, particularly when intense storms sweep over low-lying coastal areas. Some scientists believe that the maximum wind speeds in a hurricane can be reduced by seeding, using chemical agents such as silver iodide. Based on this hypothesis, the U.S. launched Project Stormfury, in which planes flying into hurricanes deposited the seeding agents. Of the half dozen experiments on the hurricanes which were carried out in the Gulf of Mexico in the South Atlantic, apparently the most successful involved Hurricane Debbie in August of 1969. Seeding was followed by periods in which peak winds decreased substantially at levels at which the aircraft were flying. Changes, if any, at other levels were not observed. These experiments have led proponents of this kind of weather modification to be cautiously optimistic as to the prospects. The U.S. Government, including the National Security Council, the State Department, the Department of Defense, and the Department of Commerce, deliberated on the future of the program and on whether or not it should be shifted to the Pacific where typhoons are more frequent than are hurricanes in the Caribbean.

Rainmaking As a Weapon

As noted above, rainmaking has been used as a weapon of war only by the United States in the Vietnam conflict. As a result of work conducted mainly in the Naval Ordnance Test Station in China Lake, Calif., together with the National Academy of Sciences' 1966 favorable view on rainmaking, the Office of Defense Research and Engineering proposed in 1966 a concept of using rainmaking techniques in Southeast Asia as a means of inhibiting the logistical operations of the North Vietnamese along the Ho Chi Minh Trail. Tests using specially designed seeding equipment developed at China Lake were conducted in the Laos Panhandle. It is not clear from the unclassified literature whether these tests had either National Security Council or State Department authorization, although a reading of the relevant congressional hearings indicates that the State Department was not informed of these early tests. In November of 1966, the Commander-in-Chief of the Pacific reported the tests were completed and forwarded the results to Washington for evaluation by the Defense Department.

The only persons outside the security establishment given access to the data were members of the staff of the then-existent Office of Science and Technology and the President's Science Advisory Committee. The latter group recommended to President Johnson against the operational use of rainmaking techniques, for both technical and political reasons. The results of the tests that had been conducted were inconclusive with respect to the efficacy of rainmaking, and the military usefulness of increased precipitation was doubtful. While these operational considerations were important, the dominant issue was that of international repercussions. Over the years close cooperation and exchange of weather data among almost all countries has been achieved. Meteorological data secured by other countries is a great aid to weather forecasting in the United States, and the forecasts for those in such industries as agriculture and construction have a high economic value, certainly measured in the tens of billions of dollars. Through the efforts of the World Meteorological Organization, observations taken in virtually every country having a meteorological service are exchanged with almost all nations. North Vietnam and North Korea are the principal exceptions. If it became known that the U.S. was using meteorological techniques as a weapon of war, then these cooperative efforts might be threatened with consequent domestic economic penalties. In fact, although many countries publically criticized the United States for its actions once they became known, there was no disruption in international weather data exchange.

The White House, presumably through then-National Security Advisor Walt W. Rostow, authorized an operational phase of rainmaking which began on March 20, 1967. The rainmaking operations were conducted each subsequent year during the rainy southwest monsoon season until July 5, 1972. The areas seeded were over Laos, Cambodia and both Vietnams. Because the program was considered so politically sensitive, responsibilities for it were lodged within that part of the Joint Chiefs of Staff responsible for covert operations. The reporting process was designed to limit knowledge of the program and special communications channels were used to describe actual operations. Over normal channels the flights were reported as reconnaissance flights. The aircraft operated out of Vietnam. At various times during the operation different geographical areas were seeded and when the bombing was restricted to the area south of the 19° north latitude in 1968, seeding operations were similarly restricted to the approved area. All in all, 2,602 sorties were flown and 47,409 cannisters containing seed-

ing agents were injected into clouds in the five years of operations.

The effect of the rainfall on the logistical operations is not known, since the operations conducted over enemy territory did not lend themselves to easy verification. Evidence presented by the Defense Department indicates that the effects were minimal. For example, in much of the area the rainfall during the monsoon season averages about 21 inches and the induced rainfall is said to have been an additional two or three inches. Any increase in rainfall during a period when rains are already heavy is likely to have minor consequences on the logistic traffic.

The Senate Begins Its Inquiry

Since about 1400 people were given access to information about the rainmaking project during its existence, it is not surprising that leaks began to appear in the press. In September of 1971 Senator Claiborne Pell of Rhode Island, as Chairman of the Subcommittee on Oceans and International Environment, requested the Department of Defense to provide information with respect to the program. By December D.O.D. had replied that the relevant chairmen of the committees with primary responsibility for defense had been informed and there was no need to provide further information to the Subcommittee of the Committee on Foreign Relations.

In March, 1972, Senator Pell introduced a resolution that urged the executive to seek an agreement with other countries prohibiting the use of weather modification as a weapon of war. This move led the Undersecretaries Committee, an interagency committee designed to deal with security matters affecting several agencies, to set up a group to prepare a coordinated response. In replying to Senator Pell, the position of the group was that the Undersecretaries Committee had undertaken a study of weather modification in the spring of 1971. But, they said, that study was not yet completed and therefore the Committee had come to no conclusions with respect to military uses of weather modification. Chief among the reasons for this inconclusive result were D.O.D.'s and the National Security Council's strong reservations about a total ban on the use of weather modification. Furthermore, most members of the study group and most members of the parent Undersecretaries Committee were not cleared for information with respect to Southeast Asia operations and were not aware of them except through speculation in the press. The extreme level of classification made any meaningful investigation of the military uses of weather modification impossible even though the officials involved were in high positions within their respective agencies.

	Sorties flown	Units expended	
1967	591	6,570	(including 1,017 over North Vietnam)
1968	734	7,420	(including 98 over North Vietnam)
1969	528	9,457	
1970	277	8,312	
1971	333	11,288	
1972	139	4,362	(Laos, Cambodia, South Vietnam)
Totals	2,602	47,409	

Call the project Popeye, Compatriot, or Intermediary, the fact remains that between 1967 and 1972 the U.S. Air Force dropped 47,409 cannisters of silver iodide on Southeast Asia in an attempt to increase rainfall over the Ho Chi Minh Trail.

While the executive study led to no action, hearings on the Pell resolution were held in July, 1972, with government officials and their Office of Management and Budget-cleared testimony opposing enactment of the resolution. The Senate, however, in July, 1973, overwhelmingly adopted a slightly modified version of the Pell resolution by roll-call vote. The executive branch did not respond to the resolution, so the issue was next joined at Secretary of State Kissinger's confirmation hearings in September, 1973, when he was asked about the Senate resolution. Dr. Kissinger's reply came in the form of a November letter stating that it was not yet possible to provide a coordinated executive branch response to the Senate resolution.

Senator Pell continued his pursuit of the issue by calling for further hearings in January, 1974. As before, the executive representatives were less than forthright. However, the Department of State assured the Committee that the President had directed the Department of Defense to carry out a study of military aspects of weather and other environmental modification techniques. Needless to say,

Senator Claiborne Pell (D-R.I.) prepares for the July, 1972, hearings on his proposal to urge the executive branch to seek an international treaty banning weather modification as a weapon. Senator Pell and his colleagues were met with considerable resistance from the White House and Department of Defense, for at the same time the government was secretly seeding clouds over Southeast Asia to increase the impact of the monsoon there. (Photo courtesy of the Office of Senator Pell)

Senator Pell and the public witnesses during the hearings took a somewhat dim view of the Department of Defense studying its own activities. In March, 1974, the Department of Defense did provide the subcommittee with a complete "Top Secret" briefing on weather modification activities in Southeast Asia.

During the hearings it was revealed that because of the supposed political sensitivity of the operations the number of high officials in government who were aware of the activity was extremely limited. Indeed, Secretary of Defense Laird had to reverse his statement to the Foreign Relations Committee that rainmaking had not been used over North Vietnam. Even though Laird had been Secretary of Defense during the critical period of U.S. disengagement in Vietnam, he was not aware that the rainmaking activities were underway or that they had been initiated during the Johnson Administration.

Political Consequences of Rainmaking in Southeast Asia

The story of environmental warfare and its political implications did not end with the Pell hearings. The State Department during the spring of 1974 was desperately attempting to develop a disarmament proposal for the summer summit meetings. Over strong defense objections, the executive decided to put forward at the summit a proposal to the Soviets for bilateral discussions on the banning of the use of environmental warfare between the two countries. The summit communique of July 3, 1974 announced the commitment that both countries would enter into talks on the subject. Since then preliminary talks have been held between the two countries. In July press reports indicated that an agreement might be signed in the fall of 1975. However, the executive continued its position of reluctance in discussion of the issue. The executive refused to provide a witness for a hearing on the subject held in July before the House Committee on International Relations. The decision to enter into these discussions was politically motivated. Because of a lack of an adequate technological input into the discussions leading to the summit, some of the dangers of not limiting the scope of the discussions were overlooked. Indeed, the Soviets soon took advantage of the lack of a definite U.S. position on environmental warfare.

On August 4, 1974, Ambassador Gromyko introduced in the U.N. General Assembly a draft international convention which was circulated at the organizational session of the First Committee of the U.N. in September of the same year. The Soviet proposal is far-reaching and would ban such sensitive and potentially intelligence-related items as any action that would influence electrical activity of the atmosphere, or continuous acoustic or electromagnetic fields in the ocean or atmosphere. It also contains provisions which are specifically directed against real and alleged U.S. activities in Southeast Asia such as the use of herbicides, rainmaking, and the bombing of dikes, as well as such subjects as the initiation of earthquakes and tidal waves, the alteration of climate, the melting of ice caps, and cutting holes in the ozone layer.

The Soviet proposal caught the U.S. Government completely by surprise. The Soviet position was that the U.S. and the Soviet Union would engage in bilateral discussions before any attempt was made to achieve an international agreement. The State Department, with its inadequate technical resources and heavy reliance on the Defense Department, had to grapple with the question of how to deal with this politically embarrassing issue. The United Nations, however, acted swiftly and in a resolution called for the convening of a meeting to draft a convention along the lines proposed by the Soviet Union. The U.S. labelled the proposed convention as being too general and too vague.

Prospects For the Future

The history of rainmaking in Southeast Asia clearly illustrates the problems inherent in the use of a new technology, when that technology is poorly understood and when such use carries with it multiple political implications. The technologists associated with the program oversold their product and, for political reasons, decision makers decided to keep non-defense scientists from critically evaluating the program. The breakdown in communications between those in the State Department, with the responsibility for protecting the overall U.S. foreign policy position, and the Defense Department became complete when the program began operation.

To some, rainmaking may seem relatively innocuous as compared with bombing or napalm. In some sense this is a correct view, but in the broader view the implications for future political stability are immense. We are developing a far more detailed understanding of the earth and its surroundings. With this understanding comes the capability to alter nature in major ways. The evidence is now overwhelming that the use of Freon in aerosol spray cans will bring about a decrease in the ozone layer of the stratosphere, our shield against the biologically damaging ultraviolet rays of the sun. Man has triggered earthquakes by pumping fluids underground and by creating reservoirs.

It may be possible in the future to trigger earthquakes with devastating results from a great distance, or to bring about major climatic changes by triggering the instabilities inherent in the Antarctic icecap. All of these possibilities seem today to be far-fetched. But our history has shown us that if a technology develops, it will be used, unless international agreements can be secured.

We already possess highly effective tools for destruction. However, as I argued ten years ago, it may be to a nation's advantage to engage in covert warfare rather than overt warfare to secure national advantages. As economic competition among advanced nations heightens and the availability of natural resources decreases, it may be to a country's advantage to insure a peaceful natural environment for itself and a disturbed environment for its competitors. A nation could carry out covert operations producing disturbed conditions since nature's great irregularities permit storms, floods, droughts, earthquakes and tidal waves to be viewed as unusual but not unexpected. Such a secret war need never be made public or even known by the affected populations. It could go on for years with only the security forces involved being aware of it. The years of drought and storm would be attributed to unkindly nature and only after a nation was thoroughly drained economically by its disrupted environment would an armed takeover be attempted.

These possibilities need to be taken seriously. Policymakers in government must be made aware of the long-range consequences of developing certain kinds of technologies for other than peaceful purposes. The lesson of the Vietnam experience is not that rainmaking is an inefficient means for slowing logistical movement along jungle trails. Rather the lesson is that covert operations using a new technology can be carried out in a democracy without the knowledge of the people. This lesson has far-reaching implications as environmental technology makes rapid progress.

U.S. and Soviets Propose Weather Pact

As this issue of *Technology Review* went to press, the United States and the Soviet Union submitted to the Geneva disarmament talks a joint proposal for a pact to outlaw weather or other environmental modification as a weapon.

The submission in late August marked the first major advance in the 30-nation talks since the 1971 adoption of a treaty outlawing germ warfare.

The proposed nine-article convention, not released until August, would prohibit nations from engaging in "military or other hostile use of environmental modification techniques having widespread, long-lasting or severe effects as the means of destruction, damage or injury to another state," according to an article in the August 22 *New York Times*. This precludes the use of techniques which might cause earthquakes, tidal waves, ecological imbalance, or atmospheric changes, besides the more widely publicized possibilities of weather and climate modification.

The draft will not be debated until the conference resumes in the spring of 1976, but Joseph Martin Jr., U.S. representative to the talks said that he was convinced the treaty would be approved in time for submission to the 1976 session of the United Nations general assembly.

The joint proposal resulted from talks between President Nixon and Leonid Brezhnev in Moscow in July, 1974. — *D.M.*

Suggested Readings

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Weather and Climate Modification: Problems and Progress. National Academy of Sciences, Washington, D.C. 1973.

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Gordon J. MacDonald in *Unless Peace Comes,* edited by Nigel Calder, The Penguin Press, London, 1968.

Gordon MacDonald is the Henry R. Luce Third Century Professor of Environmental Studies and Policy at Dartmouth College. As such he is also director of the Environmental Studies Program at Dartmouth and a Professor of earth sciences.

He is a member of the Department of State's Advisory Committee on Science and Foreign Affairs, and has served on the President's Science Advisory Committee, and numerous other federal advisory bodies. He is a member of the National Academy of Science and Chairman of the Academy's Commission on Natural Resources. He is a graduate of Harvard University, and has served as faculty member and administrator at the University of California. He has been an assistant professor and an associate professor of geophysics at M.I.T.

Help a Farmer Build a Bridge

Puzzle Corner
by
Allan J. Gottlieb

As we start another year, let me welcome back our regular readers and say hello to newcomers.

For the latter, here are the ground rules: Each month we publish five problems and several "speed problems," selected from those suggested by readers. The first selection each month will be either a bridge or a chess problem. We ask readers to send us their solutions to each problem, and three issues later we select for publication one of the answers — if any — to each problem; we also publish the names of other readers who submitted correct answers. Answers received too late or additional comments of special interest are published as space permits under "Better Late Than Never." And I cannot respond to readers' queries except through the column itself.

Here goes.

Problems

O/N 1 We begin this issue with a bridge problem from Kenneth Barbour (both bridge and chess problems are in short supply). At a recent bridge party North and South had the following hands:

♠ K
♥ A Q 9 8 7 6 2
♦ 9 8 4
♣ J 10

♠ A Q J
♥ J 10 5 3
♦ A K Q 5
♣ K 6

I sat as South and bid six diamonds only to discover six hearts was beginners' play. However, six diamonds is a good exercise and was made. By playing all probabilities to the fullest, seven diamonds could be made; the problem is to show how, given the fact that neither East nor West bid. West's lead was ♠2.

O/N 2 Roger Lustic has a problem concerning magic cubes: Is it possible to construct a 3 × 3 × 3 magic cube in which the elements are not all identical? (A magic cube of size n × n × n is a cubic array of numbers in which any set of n colinear numbers totals a constant magic sum S.)

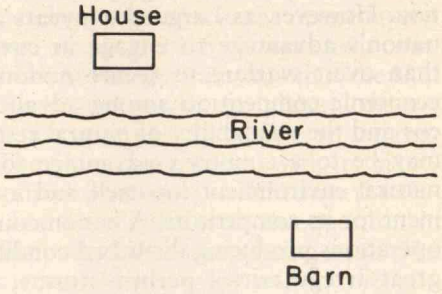
O/N 3 This problem, from James Edmonds, seems very hard to me. Perhaps the physicists in my audience (and others, too?) will show me up. There are two parts:

A. Complex numbers of the form $c = a[e_0] + b[ie_1]$ have *one* kind of "complex conjugation," $c^* \equiv a[e_0] - b[ie_1]$. Here $[e_0][e_0] \equiv [e_0]$, $[e_0][ie_1] \equiv [ie_1][e_0] \equiv [ie_1]$, and $[ie_1][ie_1] \equiv -[e_0]$. This conjugation has the property $(cc')^* = c'^*c^* = c^*c'^*$. Note that $\equiv$ is used to represent "equals by definition." Complex quaternions (or "hypercomplex" numbers)

$$q = a[e_0] + b[ie_0] + c[e_1] + d[ie_1] + e[e_2] + f[ie_2] + g[e_3] + h[ie_3] \equiv \sum_{n=0}^{3} a[e_n] + b[ie_n]$$

have *two* kinds of "complex conjugation" with the property $(qq')^* = q'^*q^*$. The hypercomplex number basis elements have a simple multiplication table: $[e_0] \leftrightarrow 1$ (i.e., $[e_0]$ acts like 1), $[ie_1] \leftrightarrow i$, $[e_1][e_2] = [ie_3] = -[e_2][e_1]$ and cyclic 1, 2, 3, $[e_1][e_1] = [e_2][e_2] = [e_3][e_3] = [e_0]$, $[ie_n] \leftrightarrow i[e_n]$ for multiplication. Find the conjugations q^* and $q^{\#}$ (not so bad) and prove them unique.

B. In physics, there is a 16-element extension of this number system which also seems to describe reality in a fundamental way. We can write it $E = a_n[e_n] + b_n[ie_n] + c[f_n] + d[if_n]$, where again sum on $n = 0, 1, 2, 3$. Let $E \equiv e + f$ for short. Then $E^+ \equiv e^* + f^{\#}$ and $E^{\wedge} \equiv e^{\#} + f^*$ and $E^{\vee} \equiv e^{\#} - f^*$, and all have the property $(EE')^{conj} = E'^{conj} E^{conj}$. The question is open, so far as I know, as to whether any other conjugations can be defined with this property. The multiplication table is as follows: $e \leftrightarrow f$ and $e \leftrightarrow f$; that is, f is like e with respect to $()^*$ and $()^{\#}$; e and f are like (+) and (−) in multiplication, $ef \rightarrow f$, $ee \rightarrow e$, $ff \rightarrow e$, $fe \rightarrow f$; if f is the *left* multiplier only, then fe is like ee given before ($[f_1][e_2] = [if_3]$); if f is the *right* multiplier then $()^{\#*}$ is taken on the *left* before the regular multiplication is done ($[e_1][f_2] \rightarrow [e_1]^{\#*}[f_2] = -[e_1][f_2] \rightarrow -[if_3]$ and $[if_1][f_2] \rightarrow [if_1]^{\#*}[f_2] = +[if_1][f_2] \rightarrow -[e_3]$). I invented this number system (which is isomorphic to Eddington's E-numbers and the Dirac-Clifford algebra) while trying to extend the complex quaternion system to fit mass into the relativistic quantum wave equation (heavy stuff — ed.). Anyone interested in this material should read the proposer's article in the *American Journal of Physics* (Vol. 42) or/and contact him at San Diego State College.



O/N 4 In a somewhat lighter vein, we have the following agriculture problem from Ray Brinker: A farm is cut by a river flowing from east to west, the house on one side, the barn on the other. The farmer wants to build a north-south bridge from his house to his barn. Where should he locate the bridge to minimize his walk from house to barn?

O/N 5 This problem from Robert Baird sounds hard (a proof — in number theory, no less!), but it's not so bad: Prove that any set of n integers (not necessarily distinct) contains a nonempty subset whose sum is divisible by n.

Speed Department

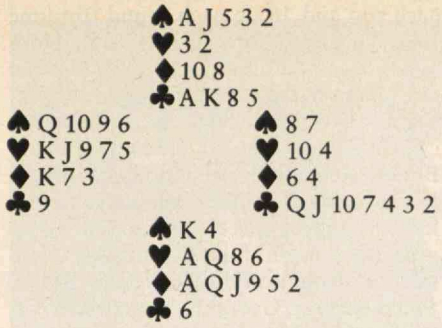
O/N SD 1 Here is a speed problem from R. Robinson Rowe which even I could solve quickly: Maine, Iowa, Utah, and Idaho do not recognize hereditary barrenness as legal justification in a suit by a husband for a divorce. Why?

O/N SD 2 Ted Mita knows that February 29, 1972, was a Tuesday. When will February 29 next be a Tuesday?

Solutions

The following solutions are to problems published in the May, 1975, issue of *Technology Review*.

MAY 1 South dealt the following hand with neither side vulnerable:

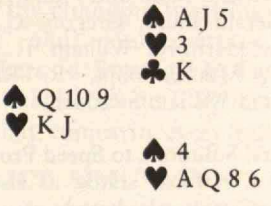


North-South use Blackwood, and the bidding was:

S	*W*	*N*	*E*
1D	1H	1S	P
3D	P	4D	P
4NT	P	5H	P
6D	P	P	P

Use the bidding (and not the East-West hands) to guide you to South's winning play.

The following is from William Butler: Since West bid one heart, it is apparent that South assumes West has most of the outstanding high cards, including the ♠Q and the ♥K. Also, since West bid hearts he might possibly be short in some other suit. Therefore, efforts should be made to keep East out of the lead (where practical) to prevent a possible club lead and ruff or a heart lead through South's ♥A and ♥Q. In the play of the hand South must not lead hearts until a squeeze position develops (or other problems are solved), and he cannot finesse the ♠J until after the ♠K has been played. If West leads a heart, South's problem is immediately solved and 12 tricks are produced with a simple spade finesse. If West leads a diamond or a club, South wins in the dummy and immediately leads diamonds (overtake the second diamond in his own hand). After West takes the ♦K, South winds any return, runs diamonds, and takes the ♠K until the following position develops:

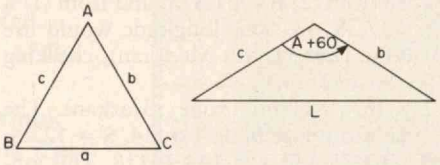


South now leads the ♠4 and finesses dummy's ♠J. South leads ♣K from dummy and discards a heart. West must unguard either spades or hearts. Note that if West could lead a second club after winning the ♦K, then the squeeze would develop when South leads the last diamond. If West's initial lead is a spade, South must win in his own hand and not take the finesse immediately. He must then pull trumps without using clubs as an entry to take a diamond finesse, by first leading a low trump from his hand and using the ♦A on the second diamond trick. (Any other combination leads to re-entry problems.) When West has the lead with the ♦K, the situation is similar to that described above as long as he returns something other than a spade. If he returns a spade (his second spade lead), South finesses the ♠J and returns to his hand by ruffing a third spade. South wins the remaining tricks by running diamonds, taking the ♥A, and using the carefully preserved club entry to take the clubs and remaining spades.

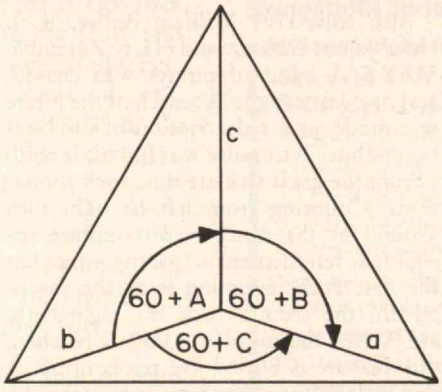
Also solved by William Delehanty, Emmet J. Duffy, Winslow H. Hartford, Richard I. Hess, R. Robinson Rowe, and the proposer, Michael Kay.

MAY 2 Given three lengths a, b, and c ($a < b + c$, $b < a + c$, and $c < a + b$), find the side of an equilateral triangle, inside which a point joins the three vertices with distances a, b, and c.

Robert Kimble feels that the point in question should be required to lie inside the circumscribed circle, not the equilateral triangle. His solution is to construct a triangle with sides a, b, and c and call its area X. Now he constructs a triangle with sides b and c and included angle (A + 60) and claims that the side opposite the angle (A + 60) is the desired length. Proof:



Proof: Let L be this desired length. Then $L = b^2 + c^2 - 2bc \cos(A + 60) = b^2 + c^2 - 2bc(\frac{1}{2}\cos(A - \sqrt{3})/\sin A) = b^2 + c^2 - bc \cos A + \sqrt{3}bc \sin A = b^2 + c^2 - bc(b^2 + c^2 - a^2)/2bc + 2\sqrt{3}X = \frac{1}{2}(a^2 + b^2 + c^2) + 2\sqrt{3}X$. Thus the length, 1, is clearly independent of which pair of sides was chosen. The completed diagram would then be the following:

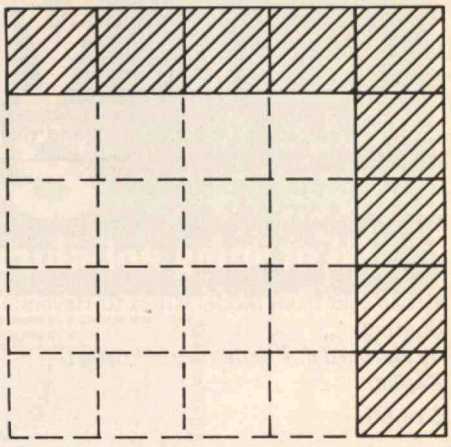


Also solved by Gerald Blum, William Butler, Bob Lutton, Robert Pogoff, R. Robinson Rowe, Frank Rubin, Hal Vose, and the proposer, Eric Jamin.

MAY 3 Show that for any integer $A > 2$, there exist integers B and C such that $A^2 + B^2 = C^2$.

Neil Hopkins sent us both graphical and analytical solutions. First the pictures:

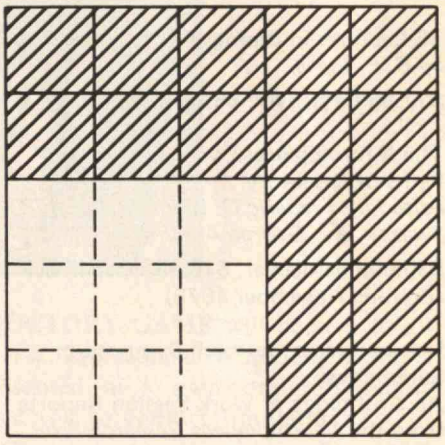
A is odd. Arrange in equal vertical and horizontal legs, single lines, the total value of A^2. The following example is for A = 3:



From this drawing, A^2 encloses on two sides B^2, and the total is C^2. From this it follows that the values of B and C are:

$B = (A^2 - 1)/2$, and $C = (A^2 + 1)/2$.

A is even. Arrange the value of A^2 in a double vertical and horizontal row. The following example is for A = 4:



From this drawing, $B = (A^2 - 4)/4$, and $C = (A^2 + 4)/4$.

Analytically, Mr. Hopkins also separates the two cases: A is odd, $A^2 = A^2 \cdot 1 = [(A^2 + 1)/2 + (A^2 - 1)/2] \cdot [(A^2 + 1)/2 - (A^2 - 1)/2] = [(A^2 + 1)/2]^2 - [(A^2 - 1)/2]^2$.

A is even, $A = A^2/2 \cdot 2 = [(A^2 + 4)/4 + (A^2 - 4)/4] \cdot [(A^2 + 4)/4 - (A^2 - 4)/4] = [(A^2 + 4)/4]^2 - [(A^2 - 4)/4]^2$.

Also solved by Gerald Blum, William Butler, Emmet J. Duffy, Kenneth Friedman, George Grover, Winslow Hartford, P. V. Heftler, Richard I. Hess, Ken Kiesel, Judith Q. Longyear, Bob Lutton, Thomas O. Mahon, Jr., James H. Michelman, John D. Mill, William J. Moody, Avi Ornstein, R. Robinson Rowe, Frank Rubin, Norman M. Wickerstrand, and the proposer, Winthrop Leeds.

MAY 4 Starting at zero-zero latitude and longitude at 12:00 M on Sunday, Aaron Ott flew his plane at a constant 225 knots loxodromically North 60° West. Where

was he at 12:00 M on Monday?

The proposer, R. Robinson Rowe, set two traps and no one else avoided both pitfalls. The first trap is that you are to use local time, the second is that there are *two* solutions. His solution follows:

Let λ = west longitude, θ = north latitude, ϕ = colatitude = $90° - \theta$, A = rhumb angle between path and meridian, V = velocity, S = length of path in degrees, and T = elapsed time in hours.

From the general differential equations of the loxodrome, $d\lambda = \pm \tan A \cdot d\phi / \sin \phi$ and $dS = \sec A \, d\phi$, the boundary conditions derive the particular relations:

$$\lambda = 180\sqrt{3}/\pi [\ln \cot (45° - \tfrac{1}{2}\theta)] \quad (1)$$

$$S = 2e \quad (2)$$

$$T = 4S/15 \quad (3)$$

(If this is not clear, note that A = 60°, tan A = $\sqrt{3}$, sec A = 2, and that V = 225 knots is equivalent to 3.75° per hour.)

Note first that when Aaron Ott had flown 24 hours, he would be in a different time zone where it would not yet be 12:00 M. From a rough approximation or graphical solution, it appears that he will meet that time condition in the ninth or tenth time zone west of the Greenwich meridian.

Try the ninth time zone (Yukon). Then T = 24 + 9 = 33. From (3), S = 123.75. Then from (2) $\theta = 61.875$, and from (1) $\lambda = 137.38163$. This longitude would use Yukon Time (135th Meridian), checking the assumption.

Try the 6th time zone (Alaskan). The same procedure finds T = 34, S = 127.5, $\theta = 63.75$ and $\lambda = 144.49218$. This longitude would use 150th Meridian (Alaskan) Time, also checking the assumption. Thus there are two solutions; twice on Monday Ott passes over spots where standard time is 12:00 M, viz:

1. At latitude 61° 52′ 30″, longitude 137° 22′ 54″, on the Nisling River north of Aishinik, YT.
2. At latitude 63° 45′, longitude 144° 29′ 32″, on the Tanana River near Dot Lake, Ak.

Also solved by William Butler, R. I. Hess, James Shearer, and Harry Zaremba.

MAY 5 A band of pirates was chased, and one was caught. A search of the pirate was made, and a description of the location of buried treasure was found; it read: "From the great tree are nine rock formations. Counting from left to right turn around at the ninth rock counting the eighth as ten then again turning around at the first rock, counting it as the seventeenth, the second rock the eighteenth, etc. When the number 1,000 is reached, the treasure is buried five paces north of this rock." One of the natives read this description and immediately figured out where the treasure was located without going through all the steps. What formula did he use? And near what rock was the treasure buried?

Edward Friedman found this to be almost too easy. His solution: Except for the first trip, eight piles are counted on each trip and 16 on each round trip (one must be added for the first trip). Since 1,000 is an odd multiple of 8, we must be one pile from the end on a "forward" trip. Therefore we must be at the eighth pile.

Also solved by Gerald Blum, William Butler, Kenneth Friedman, Ben Gunter, Winslow Hartford, R. I. Hess, Neil Hopkins, Winthrop Leeds, Judith Q. Longyear, Bob Lutton, John D. Mill, Avi Ornstein, R. Robinson Rowe, Frank Rubin, James Shearer, George Sinclair, Hal Vose, Anthony M. Weiner, and Harry Zaremba.

Better Late Than Never

JAN 1 The published solution is wrong; the final position is not mate! To explain how I could have failed to notice this obvious shortcoming, I should mention that the only chess award I have ever received is the Horatio Q. Patzer Award for the most rapid resignation at a Rockefeller University simultaneous event. The following solution is from Norman M. Wickerstrand and Jack O. Dunn:

1	N − QB7	ck	K − Q5
2	R − B4	ck	P × R
3	P − B3	ck	P × P
4	P × R	ck	P × P
5	R − K4	ck	P × R
6	B − K5	ck	P × B
7	N(Q6) − N5	ck	R × N (a)
8	Q − Q8	ck	Q − Q3 (b)
9	Q × Q	ck	B − Q4
10	Q × B	ck	P × Q
11	N × R	mate	

(a) If P × N, white's penultimate move is mate.

(b) If B − B4, skip the next move.

Responses were also received from Peter Bishop, Michael Laufer, Charles H. Pierce, Frank Rubin, and Jerome J. Taylor.

Solutions have also come from the following to the problems indicated:

DEC 2 Uri Reychav and Frank Rubin.
JAN 2 David Kaufman.
JAN 4 William J. Butler.
JAN 5 William J. Butler.
M/A 1 Gerald Blum and Frank Rubin.
M/A 3 Gerald Blum, Gregory C. Daley, Winslow Hartford, William T. Moody, Carl F. Muchenhoupt, R. Robinson Rowe, and William Swedush.

Proposers' Solutions to Speed Problems

O/N SD 1 In those states, as elsewhere, barrenness cannot be hereditary.

O/N SD 2 February 29, 2000. There is always a gap of 28 years unless some peculiar year like 1900 (multiple of 100 but not 400) intervenes.

Allan J. Gottlieb studied mathematics at M.I.T. (S.B. 1967) and Brandeis (A.M. 1968, Ph.D. 1973); he is now Assistant Professor of Mathematics at York College of C.U.N.Y. Send problems, solutions, and comments to him at the Department of Mathematics, York College, 150-14 Jamaica Ave., Jamaica, N.Y., 11432.

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- **The East is Red**
- **PanzerArmee Afrika**
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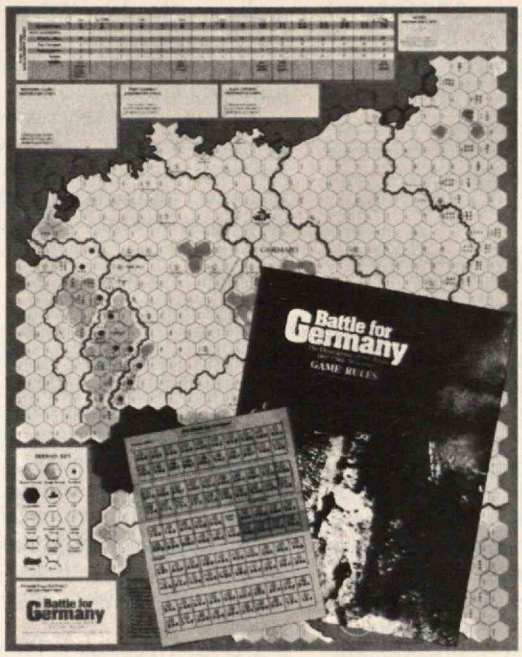
- **Operation Olympic**
- **American Civil War**
- **Combined Arms**

(Note that all these games are now available in their separate $8 boxed versions.)



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Book Reviews

Technology With a Human Face

Small is Beautiful
E. F. Schumacher
New York: Harper and Row, 1973, 290 pp., $3.75 paper

Reviewed by Stuart Chase

In 1940 there were 31 million Americans down on the farm. If this rural group had increased at the same rate as total U.S. population, there would be 49 million on the farm today. There are only nine million.

Where have the farmers gone? To the cities looking for work. U.S. city dwellers increased by 51 million from 1940 to 1974, and the primary reason has been the industrialization of agriculture.

Tractors, gang plows, chemical fertilizers, pesticides, pumps for irrigation, are now doing most of the heavy work, powered by petroleum, and directed by a few experts.

Meanwhile in the cities, assembly lines, automatic machines and computers can turn out goods faster than demand will absorb them, and are building up a permanent body of technological unemployment. "Untouched by human hands," the ads proudly proclaim. So what happens to the hands? More unwanted human labor to add to vanishing farm hands.

Perhaps almost as serious in the cities is the utter boredom of work on the belt: "I turn around and there's another crank shaft staring me in the face!" Hour after hour, day after day, year after year, until the unsold cars pile up in a recession, and the belt stops running.

One can build a devastating argument against high technology and the injury it inflicts on the human condition. Jacques Ellul builds the argument so strongly that he sees no solution but retreat to a handicraft economy, if not to the Stone Age. But this is a typical either/or decision. Is there no middle ground?

There is, and a British economist, E. F. Schumacher, is presenting it forcibly. He gives his system various labels — "intermediate technology," "self-help technology," "appropriate technology" — but I like to call it "mini-technology" in contrast with all-out, smash-bang, high technology. Inanimate energy yes, but within reason, not at the cost of creeping technological unemployment, or at the cost of a life-time on the belt. Machines, yes, but keep them in scale with a human being. This I take to be Dr. Schumacher's theme.

Design for Living

I watched Dr. Schumacher on television the other night as he developed the case for mini-technology. He was very sure of himself, there on the screen, with a fine, strong face, more scientist than ideologist. Born in Germany in 1911, he has spent most of his life in Britain teaching economics and acting as consultant for large enterprises and various governments. He has visited Burma, India and other developing countries in the interest of his proposal.

We must develop a life-style, he says, compatible with the real needs of people. Technology has its uses, and was probably very helpful during the 19th century in the production of more goods with less labor. Now it produces too many unwanted hands. People are losing their human drive and becoming biological misfits. Meanwhile cheap energy is running out; nuclear power plants are alarmingly dangerous, the environment is progressively devastated. High technology, now dominant in both agriculture and industry, is on an anti-survival track. Yes, we need technology, but on a more intelligent plane — "technology with a human face."

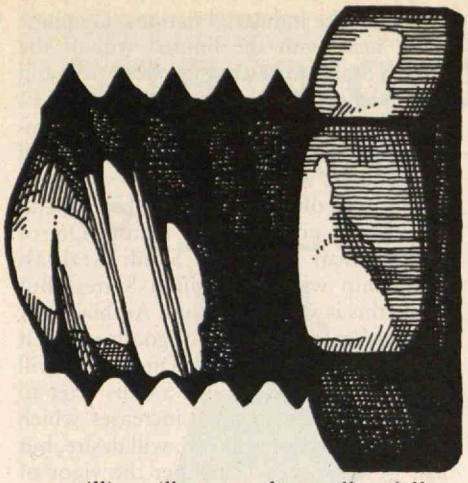
Except for Thorstein Veblen, Dr. Schumacher is the most uneconomic economist I have yet encountered. Once in a while a duly certified scholar goes whistling out of orbit, like a strayed comet. Wesley C. Mitchell of Columbia was such a one, and, if he is not careful, John Kenneth Galbraith of Harvard will be another. An uneconomic economist is one who believes that something really matters above and beyond money. "Technology with a human face."

Economics, says Dr. Schumacher, began with goods and has ended with mass production for profit and power. We need an economy that begins with people — with their hands and with their brains. Make things small wherever possible; make the work process simple and easily understood; keep the communication line free and open. Work toward lower capital-intensiveness, higher labor-intensiveness. Design a work-process which does not destroy the environment and exhaust the non-renewable resources of the planet.

We must study the economics of *permanence,* he says, and abandon the throw-away society. His theme cuts across the standard ideologies of left and right, of Tory, Labor, and Liberal. "Not bigger and more complex, but smaller and simpler." He draws a lethal bead on Dr. Sicco Mansholt of the European Economic Community, whose slogan is "More, Further, Quicker, Richer," for a constantly expanding G.N.P. He quotes Tom Dale and Vernon Gill Carter with approval: "Civilized man has marched across the face of the earth and left a desert in his footprints." North Africa, the Near East, the American dust bowl. High technology, he says, regards agriculture as just another steel mill; it must pay its way in dollars or go under. In which event, friends, how do we eat? Nature abhors monoculture in crops. Diversify, says Dr. Schumacher, or die.

A normal man needs work for hand and mind in his own time, at his own pace, and with the best of tools to aid him. The poor of the world cannot be helped much by industrial mass production, only by improvements in their own work habits. They need productive work systems in their own village, not in vast, complicated workplaces, like Detroit or the Ruhr. There are two million villages around the world today, harboring two billion people — half the population of the globe.

We are treating fossil fuels as income, says Dr. Schumacher, when they are in reality capital. "High technology lives on irreplaceable capital, which it consumes as income." High technology is beginning to ruin poor countries with the wrong kind of investment. The workers in the



two million villages need a smaller, different sort of applied science for self-reliance and self-help. What is homo sapiens going to do when his available capital is used up; when the deep wells have no profit in going deeper?

A Pragamatic Idealism

Dr. Schumacher's idea is now taking hold in some 24 countries, aided by universities and by businessmen with the long view. Eight developing countries have now established agencies for intermediate technology. So has Switzerland in the industrially developed area, with Sweden and the Netherlands standing in line. The concept has a very useful future in the developed world, but it is in the two million villages that it is particularly and indeed desperately needed. Gradually an international network has come into being, and already has its own journal, *Appropriate Technology.*

"We do not reject anything in another people's culture." We see the need and try to find a way to meet it. We study the work-load of a specific community over a year's time. A village may be idle for a while, then furiously busy, with grandparents and children in the fields. We try to determine the right sort of simple tools and equipment which will fit the annual work curve.

The villagers immediately understand this kind of project; there is no communication problem. "Let us take people in the developing lands more seriously, and not imagine that our Western experience fits the case in Africa or Asia. *They are as intelligent as we are.*" We are stupid to force high technology on developing countries; that will only make a bad matter worse.

In Botswana and Jamaica, villagers are building underground tanks for storing water in arid areas. In various African communities natives are learning how to build better houses with local materials. In Pakistan mini-turbines for water power are being developed.

In essence, Dr. Schumacher demands an economic system which begins with people, not with the medium of exchange. He does not propose a retreat to medieval peasant agriculture but advocates modern scientific tools and methods which fit the local culture. His program neglects the Gross National Product and concentrates on the quality of life.

What we need, says Schumacher, are optimist/pessimist leaders who are keenly aware that present technological trends cannot be continued, and who have vigor enough to find a middle way. This means a system of production which makes use of modern knowledge and experience, a system "conducive to decentralization, compatible with the laws of ecology, gentle in its use of scarce resources, and designed to serve the human person instead of making him the servant of machines."

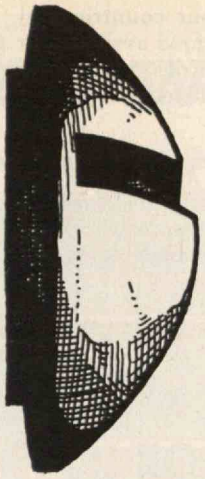
Schumacher is by no means alone in this endeavor. China, with 800 million people, most of them on the land, appears to be aiming at a labor-intensive economy with some modern equipment, rather than trying to raise the capital for a lot of factory farms. In view of the anticipated energy crises, one after another, this would seem an intelligent idea. Dr. Philip Handler, President of the National Academy of Sciences, estimates that to bring all the world, including the Chinese, up to today's standard of living in the U.S. "would require us to multiply our use of critical minerals by *seventeen*." Many of these minerals are already in short supply.

Here again are two marine biologists, John H. Todd and William O. McLarney, working at Woods Hole on a new type of food production that will be easier on nature than the factory-farm. The Rockefeller Brothers Fund is aiding them. These scientists are constructing a series of food chains which will continuously produce edible fish by natural methods alone, without benefit of chemicals or power hook-ups. The Canadian government is interested, and another experiment is to be set up on Prince Edward Island. Modern high-energy agriculture, these scientists say, with its exodus of farm workers to city slums, creates more problems than it solves.

Adding to the chorus is a rapidly growing contingent of "organic" farmers, scientific and unscientific, young and old, here and abroad, who are raising food without chemical fertilizers. They not only denounce factory-farming, but point out — only too truly — that a pound of edible meat requires at least seven pounds of edible grain — an equation that makes no sense in a chronically hungry world.

The Life-Boat Dilemma

A hard look at mini-technology raises several questions. One must search hard and long in Dr. Schumacher's various papers and statements before finding mention of the population explosion. Deep in *Small Is Beautiful,* I did find: "Pollution must be brought under control and mankind's population and consumption of resources must be steered toward a permanent and sustainable equilibrium. Otherwise the



downfall of civilization will not be a matter of science fiction." This is flat enough, but I wish he had begun rather than ended his book with the warning. I am convinced that the population explosion is mankind's number one problem. However, even with only two children per couple achieved tomorrow, the demographers tell us that it will take at least a generation before a zero population growth rate is achieved. This is due to the large percentage of persons under 15 in poor countries, who will produce more couples in the near future, if not more children per couple. The need for a mini-technology program, especially in the production of food, will continue to be desperate for years to come.

If bombs, babies and bulldozers are to be controlled, I see no escape from the political establishment of a worldwide, steady-state society. That society can make excellent use of certain elements in high technology, such as instant satellite communication, epidemic controls, the application of an unending source of solar energy, and the like.

With high technology no longer in the blundering hands of independent sovereign states or multinational corporations, but firmly controlled by competent generalists directing a steady-state world, we could decide what to keep — say solar energy, and what to skip — perhaps open-pit mining. We can assume with some confidence that very few factory-farms would be on the agenda, but mini-technology for a million or two villages should be very much in order.

Finally, mini-technology can mitigate the impending collision between poor countries and rich. Many competent observers believe this conflict — foreshadowed by the O.P.E.C. cartel, and the 1974 energy crisis — seems to be mankind's most formidable problem following the population explosion — with which, of course, it is closely allied. If, however, the poor nations can manage to feed themselves, a lot of steam will be released from the approaching conflict. And perhaps, God help us, we could thus avoid the dreadful "life-boat" dilemma which also looms. If the need for food to prevent

mass starvation in poor countries becomes greater than the food available for export from rich countries, what areas shall be saved, what left to drown? And who will decide?

Stuart Chase is widely known as writer and critic of economics and social trends. His latest book in this area is The Most Probable World. *He studied at M.I.T. with the Class of 1910.*

Observing Oil and Arabs

The Middle East, Oil, and the Great Powers
Benjamin Shwadran
New York: John Wiley and Sons, 3rd ed. 1973, xvii + 630 pp.

Reviewed by Everett E. Hagen

"The Middle Eastern countries might unite either under O.P.E.C. or O.A.P.E.C. or both and ration production, which could raise prices to levels never experienced before. Such a possibility must be anticipated, even though the objective observation of past experiences may cast a heavy shadow of doubt about its realization."

This is perhaps the boldest statement in Mr. Shwadran's book — which is to say that it is a rather pedestrian volume. It is a third edition; Mr. Shwadran unluckily completed his second revision in early 1973, before the quintupling of oil prices.

The book is at best a reference history of oil discovery and exploitation in the Middle East, of negotiation and renegotiation between the oil companies and the oil exporting governments, and of the recent — and in retrospect inevitable — development of cooperation among those governments in setting prices and restricting production. It presents these facts in painstaking detail, and then adds 50 pages on the roles of Israel, Jordan, Lebanon, Syria, Egypt, and Turkey in these developments, concluding with a brief history of O.P.E.C.

Politics and Prices

All this is useful. The interested reader may learn, for example, that in 1920, the potential oil reserves of the Middle East were estimated at 4.8 billion barrels, in 1945 at 18, in 1951 at 48, in 1956 at 117, and in 1971 at 366 — but that the discovery of reserves elsewhere in the world had proceeded at such a pace that the Middle East's share of the estimated world total actually declined (to 57.6 per cent in 1971). Here Mr. Shwadran's data end. The estimates have continued to grow.

Or the reader might be amused to learn of the Standard Oil Company of New Jersey's opposition to a pipeline proposed to run from the Saudi Arabia oil fields to the Mediterranean, on grounds that the United States would never need the oil. He may be further awed by the quick reversal of the company's judgement upon admission to the Arabian American Oil Co., the project's sponsor.

Discussion of diplomatic history is rudimentary. Witness Mr. Shwadran's explanation of the ousting of Prime Minister Mossadegh by a mob in Teheran, following his proposal to nationalize Iranian oil: "backers of the Shah clashed with and overcame the supporters of Mossadegh and he was swept from office." He seems unaware of an American participation in the appearance of those "backers of the Shah." And sociology is beyond the author's ken. He views the Middle Easterners as a childish, primitive people who became modern (read, Western) more slowly than they should have as the benefits of oil money reached them.

Mr. Shwadran can hardly be blamed for doubting the oil countries' capacity for collective action through O.P.E.C.; in this failure he has the company of virtually every other observer of the oil industry in the Middle East. Today those observers are divided between the view that O.P.E.C. will continue to hold the industrial West at ransom indefinitely and that rising volume of oil production elsewhere in the world will flood the market in five years or so and break the cartel. The outcome really rests with two giants: Saudi Arabia and the United States.

To sustain the cartel price, Saudi Arabia has been content to cut production to little more than 5 million barrels a day, far below even her present productive capacity and below the rate at which new Saudi Arabian reserves are being discovered. The government believes the oil is most valuable in the ground. The second Saudi Arabian five-year development plan calls for the expenditure of $144 billion by 1980. If the country achieves this goal, its expenditures will exceed even the huge flow of oil revenues projected before 1980, and its willingness to bear the brunt of production curtailment might end.

But even if it spends at a rate far exceeding that any other country has been able to manage, it will hardly spend one third of the projected $144 billion. Even at an implausibly low level of oil production, it will have ample revenues for the lower total, and its expenditures may not reach even that figure. Its bargaining with Western companies who might become partners in energy-using projects in the country is proceeding very slowly. Responsibility for this seems to me to rest with the Saudi Arabian government more than with the companies. Add also that world demand for oil, recently very sluggish, will rise rapidly with economic recovery in the industrial nations. Combine these facts with the limited will of the United States to restrict its energy use and one must conclude, I think, that O.P.E.C. will hold together and will be able to impose high prices for a good many years if its members wish.

The price of petroleum will then depend on political, not economic, factors. One of the political factors is Saudi Arabia's friendship with the United States. But while this is very real, Saudi Arabia's fear of inflation in the prices of goods which it imports is also very real. Diplomacy will cause "the Kingdom," as Saudis refer to it, to demur at oil price increases which some members of O.P.E.C. will desire, but fear of inflation will temper the vigor of her resistance. So on balance, I believe one can expect petroleum prices to be higher in 1980 than in 1975 — higher by a ratio related to but much less than the ratio of increase in wholesale prices in the industrial countries from 1973 to 1980. Only concern for low-income countries could prevent price hikes, but other measures can be taken by the O.P.E.C. countries to resolve that problem, at least in part.

A Cultural Myopia

All this is a digression from the task of reviewing Shwadran's book. Perhaps it is more pertinent to note that Mr. Shwadran's condescending view of Middle Easterners does not become his book. The technical achievements of the West, to repeat a well-worn truth, rest upon a millenium (or, in a broader view, three millenia) of cumulative scientific and technical advance in which because of geography, not intellectual deficiency, the Middle East failed to participate. There are other, less attractive aspects of change in the West in which some Middle Eastern countries also have not participated. In Saudi Arabia one may still go to an ancient market city, as yet hardly tainted by modernity, and leave a valuable camera or ring in a car with windows open, sure that when one returns hours later it will still be there. (I plead guilty to serving, on occasion, as economic adviser to the government of Saudi Arabia and can testify to that statement's truth. It will probably not be true much longer.)

Cultural condescension hardly befits the citizen of a country whose crime rates are among the highest in the world, and whose citizens annually take billions of aspirin tablets and sleeping pills to make life tolerable. To a naïve American, most Middle Easterners seem uncouth; a professional writer should be aware that to nonwesternized Middle Easterners, Americans seem equally uncouth, and that the one judgment is as defensible as the other.

Everett E. Hagen is Professor Emeritus of Political Science and Economics and former Director of the Center for International Studies at M.I.T.

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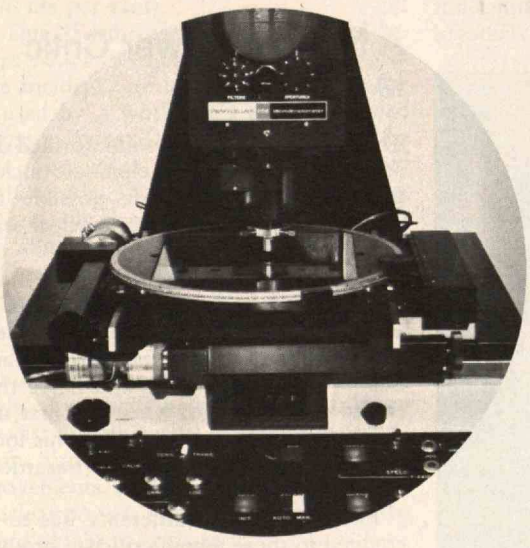

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An Institute Informant

The Editors' digest of recent and current concerns at the Massachusetts Institute of Technology

Can an Architect Be a Lady? Yes, Indeed

What happens when a women, trained as an architect, enters the man's world of building design and construction?

It's a moment of confrontation, to be sure; but don't bet on the hard-hats.

Here are some comments of alumnae of M.I.T.'s School of Architecture and Planning during a seminar of the School early in the summer:

Margaret Hickey Gintell (B.Arch. '69), Visiting Lecturer in Architectural Technology, Massachusetts College of Art, Boston: "When I became involved in site supervision, I learned to swear. If you tell them to take out the fucking beam, they actually do it! . . . I walked into the construction trailer and saw a magazine called *Tit* and perceived immediately where they were at. So next time I was baking I made some gingerbread nudes. That broke the ice. It helps a lot to deal with them on their own terms."

Marjorie Pierce, '22, Architect, Weston, Mass.: "I have three vocabularies — one for the minister, one for the job, and one for the clients. (Occasionally I have another one for the decorators!) . . . Once it is established that I know what I'm talking about, the workmen on the job give me every kind of support."

Mary S. McNulty (B.Arch. '56), Thomas McNulty, Architects, Lincoln, Mass.: "Whether an architect can establish credibility with the contractor depends on the condition of the drawings, the facts that you get from the client, and the judgments you make on the site."

Ms. McNulty practices with her husband. Problems? Not at all, she said. "Men and women always worked together in the past. Before there were architects as such in America, husbands and wives solved the design and building of houses and towns by working together in a very natural way. It's only since the Industrial Revolution that we have been separated, so I don't see what my husband and I have as anything but the most natural association. . . . Times of intensity are understood by your spouse, and you give each other moral support."

Indeed, said Ms. McNulty, "Like women in all fields, there's an empathy we all share: a concern for the least well off in society. Our tradition of nurturing is as valuable outside as inside the home. We don't throw away a good thing — the old building, the passed-down clothes . . ."

Up from the audience came Frederick A. Stahl (M.Arch '55), President of Stahl/Bennett, Inc., Boston. He agreed: "The whole nature of your conversations is rewarding to me," he said. "The missing ingredient in most architecture is common sense. . . . I am fortunate to be associated with women in my practice . . .

"Males are typically egocentric, unable to compromise. . . . There is a sense of maturity, of accommodation, that is found more often on the female side of the equation."

Why did you go into architecture? asked Marjorie Pierce, '22, (center) of four recent M.I.T. architecture graduates during the summer: (left to right) Marion Moffett, Ph.D. '75, Mary S. McNulty, '56, Margaret Hickey Gintell, '69, and Lois W. Langhorst, '40. Because a "building sense" is necessary to a person's education, they agreed. "The building process itself is a good teaching device," said Ms. Langhorst. (Photo: Roger N. Goldstein)

A Nuclear Power Critic Is Criticized

The noisy and sometimes ill-informed dissent which has sought to eliminate nuclear power has in fact made possible the nation's growing reliance on nuclear reactors for electric energy.

No surprise that David J. Rose, Professor of Nuclear Engineering at M.I.T., would prefer living next door to a nuclear reactor than to a coal-fired power plant. But he admits that if he had made that choice a decade ago, when the first nuclear plants were going on-line, his location would have been far more hazardous than now.

And much of the difference has to be credited to those whose criticism brought the U.S. Atomic Energy Commission to increasingly careful study and regulation of power plant design and construction.

But at least one of the critics is not yet ready to admit that his work is finished. Daniel Ford, a member of the ethereal Union of Concerned Scientists, mounted a thoughtful attack against nuclear power

in a debate with Professor Rose before members of the M.I.T. Alumni Council this winter. Four indictments:

— The cumulative effects of low-level, routine emissions of radioactivity taken over many years and gradually growing numbers of reactors.

— The dangers large-scale radioactivity releases through accidents from improper construction or operation of power reactors.

— The long-range problems of disposing of radioactive wastes from present and future reactor systems. ("We use the electricity and our children and their children inherit our waste.")

— The problem of security for the increasing amounts of plutonium which will circulate between reactors and fuel processors as the nuclear age matures; small amounts of plutonium — and only a little expertise — are needed to construct a nuclear weapon of terrible potential, said Mr. Ford.

Responding, Professor Rose agreed that nuclear energy "is due a great deal of respect," that "the issues are by no means simple." But having made an analysis of the societal hazards associated with the operation of 1,000-Mw. nuclear and coal-fired plants, Professor Rose comes down on the side of nuclear power. A coal-fired plant of that size may be blamed for 10, 100, perhaps 200 deaths per year — a summation of fatalities caused by accidents in mining and power plant operations and those caused by air pollution from the burning of fossil fuel. By comparison, Professor Rose's analysis suggests less than one death per year attributable, on average, to a 1,000-Mw. nuclear plant, the largest hazard associated with which is the hard-rock mining of uranium (1/6 life per year).

This "Ford-Rose debate" occurred before M.I.T.'s Alumni Council just after the incident late last winter when a fire caused by a workman's candle disabled safety systems of two reactors operated by the Tennessee Valley Authority near Athens, Ala. That incident, said Mr. Ford, graphically demonstrated his theory that no study of reactors could contemplate "all possible scenarios" for failure. "How sanguine can you be about problems that have not yet been imagined?" he asked.

True, agreed Professor Rose, and those who have put nuclear safety in the spotlight of publicity have in fact contributed to vast improvements in reactor construction and operation. Given those improvements, Professor Rose would defend nuclear power; but he would cherish Mr. Ford's right to criticize it.

Advancing Toward Underground Power

Until this summer, the highest demonstrated power transmission capacity in a cryogenically cooled underground cable

was 38 million volt-amperes (MVA), a landmark set by the Hitachi Cable Co. in Japan. The record has now been advanced to 249 MVA in a series of tests carried out at the Francis Bitter National Magnet Laboratory at M.I.T., where a vacuum-insulated, liquid-nitrogen-cooled, short single-phase loop carried 3,000 amperes at 80,000 volts.

That translates to a 138-kV., three-phase circuit capability of 720 MVA, which is three times the maximum achieved with conventional oil-paper-insulated pipe-type cables.

Bruce Montgomery and Peter Graneau, who are co-principal investigators on the M.I.T. cryocable program, explain that their goal is not to establish new records; theirs is a fundamental study of the action of electric and magnetic fields on electrons crossing the gap between a high-voltage conductor and a grounded vacuum-filled pipe, sponsored by the National Science Foundation under its program of research applied to national needs (R.A.N.N.).

But there is a practical goal: The cost of transmitting electrical energy through conventional underground cables is at least five times as much as through overhead lines, and Dr. Graneau believes the vacuum-insulated cryocable can reduce the difference to less than twice as much.

Innovation: Where Inventions Are Second

Is the M.I.T. Innovation Center an "invention factory" whose products (at best "of questionable value") represent "a personal profit-making operation" for the Institute and the inventors but not at all for the federal government, from whose National Science Foundation has come the $1.1 million on which the Innovation Center is operating?

That rhetorical question embodies the charges made this spring by Senator William Proxmire as the National Science Foundation's 1975-76 budget came up for debate in Mr. Proxmire's Appropriations Subcommittee.

True: the Innovation Center in the School of Engineering at M.I.T. is funded by a five-year $1.1 million N.S.F. grant; and the proceeds of royalties on inventions made there will be shared (if and when they come) between student inventors (35 per cent) and Institute (65 per cent). The federal government will get royalty-free licences if N.S.F. funds were used in developing a specific invention.

But all that misses the point, says Alfred A. H. Keil, Dean of the M.I.T. School of Engineering. The purpose of the Innovation Center is to stimulate invention among engineering students — to give them the habit of mind and some practical experience in evaluating and capitalizing upon new engineering ideas; to help engineering educators understand the process of innovation; and to develop teaching techniques and tools to bring the process itself to future students.

"We as engineering educators desperately need this kind of understanding of the innovation process and of how we can teach it effectively," Dean Keil thinks. He hopes some inventions made by students in the Innovation Center since the N.S.F. support began nearly two years ago will have some practical value; and if they do, M.I.T.'s share of the royalties will be used to continue the Center's program after the N.S.F. grant runs out in 1978.

In two years the project has involved some 150 students — 120 during the spring term of 1975 — and Dean Keil thinks more than 40 inventions can be identified. Among them — in addition to the banana peeler, electronic guitar, programmable record turntable, and electronic game kit which drew Senator Proxmire's ire — are a system for analyzing the purity of precious metals, a new and safer bicycle brake, a paper-making process, and a control system to optimize the operation of heating and air conditioning equipment.

Attracted by Senator William Proxmire's attack on the M.I.T. Innovation Center, CBS News Reporter Charles Osgood (second from the left) came to Cambridge this spring to look into what Alfred A. H. Keil, Dean of the School of Engineering, calls "a technique for immersing students in the real world of engineering innovation and invention." The picture shows Jacob F. Moskowitz (left) demonstrating his wide-band electric guitar with help from Ernest J. Perevoski (right). To Senator Proxmire the guitar project sounded frivolous; but Stephen Cudiltz of the Charles Stark Draper Laboratory, Inc., who volunteers part-time work at the Innovation Center, had a different story for Robert Cooke of the *Boston Globe:* "The tremendous value is in the education of the students — to encourage them to innovate, to go out and start new businesses which means new jobs, growth — supplying one of the cogs of the future."

A Bearish Report on the Panama Canal

A sea-level, lock-less replacement for the Panama Canal?

Many analysts and engineers have found it a tempting proposal, but not Norman J. Padelford, Professor of Political Science, Emeritus, at M.I.T. The fact is, he says, that ocean-going transportation no longer enjoys the monopoly it held in the Canal's early days; economics have changed; alternate routes are more feasible; and a new canal cannot be justified.

The present Canal's capacity will not be exceeded "before the turn of the century, if then," writes Professor Padelford and Stephen R. Gibbs, an M.I.T. graduate student, in *Maritime Commerce and the Future of the Panama Canal* (Ithaca: Cornell Maritime Press, 1975). And the Canal is "contributing relatively less in 1974 to the promotion of international commerce than it did in 1920," write the authors, citing recent studies which show its economic value in 1975 to be some $80 million annually.

Perhaps $32 million of this accrues to U.S. customers; hence the conclusion that "the Panama Canal, while providing the U.S. large benefits in absolute terms, is not a crucial component of its economy." A program to build additional capacity between the Atlantic and Pacific Oceans in Central America today would represent "misallocation of resources."

Lift, Drag, and Airflow

What happens when air flows over an airplane wing? A classic subject in aerodynamics usually studied in textbooks and wind tunnels. But not this year at M.I.T., where Walter M. Hollister, Associate Professor of Aeronautics and Astronautics, had devised a course which lets students "see some of the things in flight that they study in class." The one in the picture was among the experiments: pieces of yarn attached to an airplane wing let students see the airflow over it during different in-flight maneuvers. Another experiment: students atop M.I.T.'s tallest building listened to radar interrogations from the air traffic control system at Boston's Logan Airport.

The Evil Role of Underemployment

What is the real structure of the urban labor market? How do people who are dependent upon it move in and out of jobs? And how many Americans are trapped in involuntary underemployment and low-wage work in American cities?

No one knows the answers to these questions. But a few are emerging from a series of projects sponsored by the Center for the Study of Metropolitan Problems of the National Institutes of Health in the M.I.T. Department of Urban Studies and Planning in cooperation with the Research Center for Economic Planning in New York.

The goal is to develop "social indicators" that will go beyond the single dimension of unemployment in defining the failure of the urban labor market. A first result is that subemployment is a better predictor than unemployment of crime, family decomposition, drug use, and housing deterioration. Studies are continuing under the direction of Bennett Harrison, Associate Professor of Economics and of Urban Studies at M.I.T.:

— Paul Osterman, an M.I.T. graduate student in urban studies and economics, is working on the relationship of early school and work experiences to the eventual pattern of work. Who manages to "settle down" into "good" jobs, and who never finds the work he likes spending most of his life "shopping around?"

— What is the minimum wage beneath which workers will simply not accept jobs, and what forms a worker's expectation of his worth? — questions for John Pucher, a doctoral candidate in the Department of Urban Studies and Planning.

— If you start your working life in a "simple" job requiring few or no skills, are you likely to be confined to that class of jobs later in life? A central question in job mobility, the subject of work by Les Burden, a graduate student in economics.

— The migration of workers from Appalachia into the cities of Ohio, Indiana, and Illinois in the 1950s was triggered by deliberate policies of the coal industry, which no longer needed a "reserve" of local underemployed miners. That is the conclusion of Thomas Woodruff, who graduated in economics from M.I.T. last June and is now at work in the Research Department of the United Mine Workers of America. Now there's a reverse migration back to the hills, triggered by new demand for coal. Through it all, Appalachia remains an area of poverty and underemployment. Why? And can it be changed?

— What about inner-city workers who commute to suburban jobs? No panacea, says Sheldon Danziger, a doctoral candidate in economics at M.I.T.; discrimination in education and employment seems to confine ghetto dwellers to low-wage jobs, regardless of job location.

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generate significant new employment in the devastated construction industry; the cost would be no more than $1 billion.

This analysis is the work of Dr. Kenneth Rosen, Research Associate at the Joint Center for Urban Studies of Harvard and M.I.T., and the plan it proposes has been incorporated into legislation which Senator Robert W. Brooke has placed before Congress.

Dr. Rosen came to his proposal through a study of the effect of seasonal and cyclical changes in the housing industry. Summarizing that work, Professor Bernard J. Frieden, Director of the Joint Center, says that "the roller-coaster of housing production is one of the chief obstacles to meeting the country's pressing housing needs."

Housing demand, not mortgage credit, is the source of the industry's present weakness, says Dr. Rosen. He finds the construction industry the victim of "a demand crisis, caused by rising unemployment, falling real income, and a lack of consumer confidence." The $1,000 incentive payment responds to this problem by reducing the down-payment requirement and therefore relaxing "the wealth constraint" felt by many families. Dr. Rosen thinks a 10-per-cent change in down-payment requirements — which is roughly what his proposal provides — would have "three times more effect on housing starts than a 10-per-cent change in interest rates."

Let Mortgages Seek Their Proper Cost

Two radical changes in the operations of savings banks and in the terms of the residential mortgages they write are suggested by economists in the Sloan School of Management after a six-month study for the Department of Housing and Urban Development and the Federal Home Loan Bank Board.

To put more money into the sagging home-building and home-financing industries and let people use mortgages more effectively for the housing they need, Professors Franco Modigliani and Donald R. Lessard and several colleagues at M.I.T. and elsewhere propose:

— Free thrift institutions from regulations which prevent them from paying competitive interest rates for money; for example, Massachusetts savings banks are prohibited from paying more than 5½ per cent on regular savings accounts at this time.

— Let thrift institutions write "price-level adjusted mortgages," the monthly payments on which would gradually increase over the life of the mortgage in response to inflation and the increasing ability of homeowners to make higher repayments.

MIT QUARTER CENTURY CLUB

announces
an Eight-Day Charter Trip
to Travel's Most Legendary
Combination for
the incredible price of

$299**

plus 15% tax and service

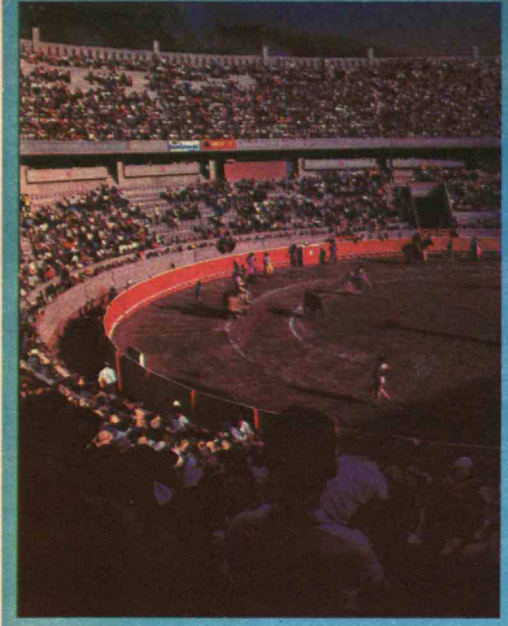
caracas

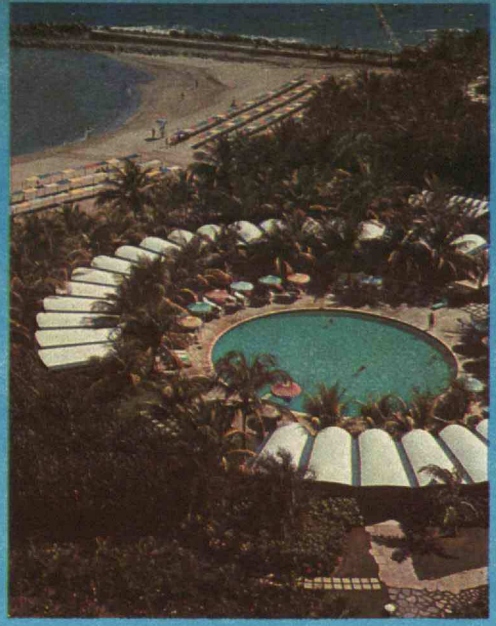
and the

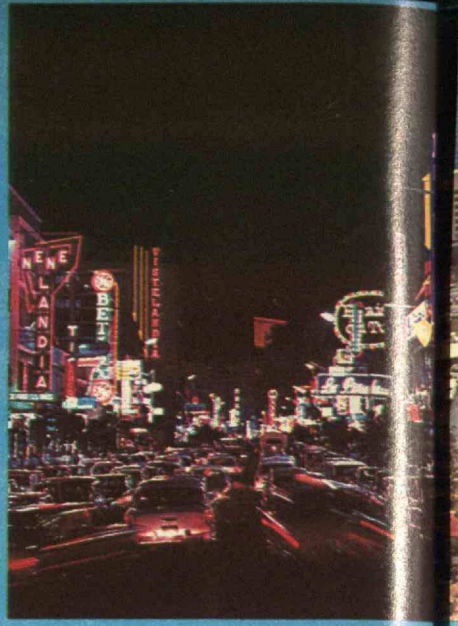
macuto sheraton

Departing from Boston
Wednesday, January 14
Returning to Boston
Wednesday, January 21

Departing from New York
Wednesday, February 11
Returning to New York
Wednesday, February 18







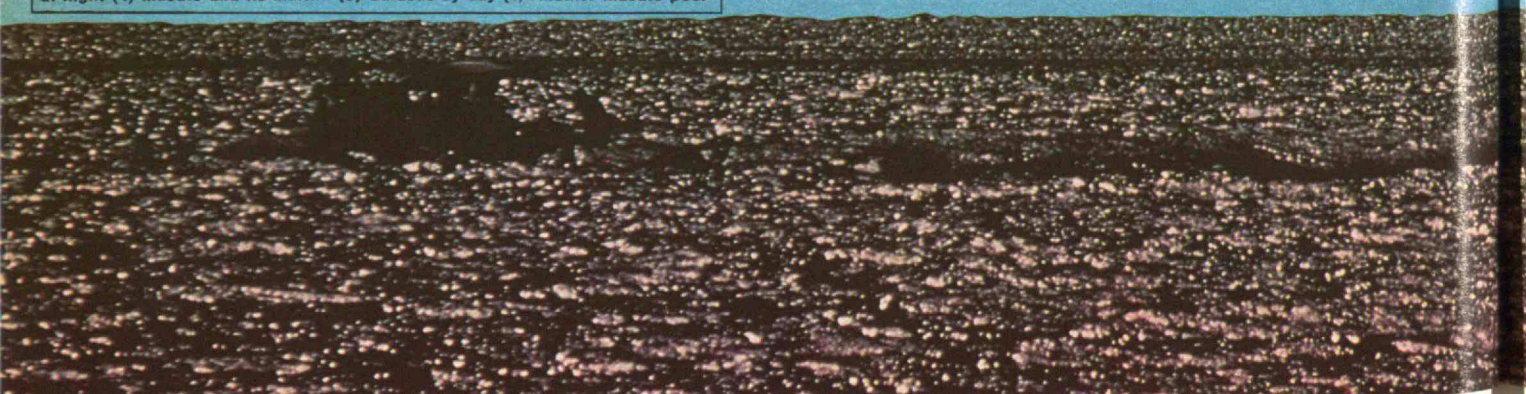
For a mere fraction of the ordinary airfare alone, we're taking an entire week-long charter flight vacation to the most exciting city in all of South America and a resort which is second to none in all the world. Here is a veritable pleasure-go-round, cradled by soaring mountains and jungle forests against the azure of a boundless sea, with a year-round perfect climate, the Latin, flamenco, and mariachi beat, shopping which overflows to underground labyrinths, and entertainment which never ends before dawn. Here monkeys play in public parks, the cable-car is daily transportation, restaurants are ennobled by garden dining, and orchids and hummingbirds grace the city streets. We can idle here in open air cafes, enjoy the world's best ice cream and steaks, visit the snowcapped Andes and the world's highest waterfall, or shop a dazzling array of boutiques. Our hotel is "the best place to stay," the site of breathtaking beaches and imposing mountains, a fishing village and yacht harbor beyond description, a resort which, with this city, is a combination unequalled in the world of travel.

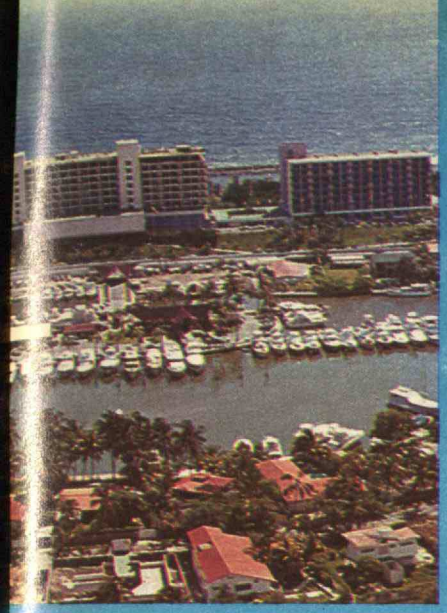
COVER PHOTOS: (1) A View from the Macuto (2) Caracas from Cable Car (3) The Macuto complex

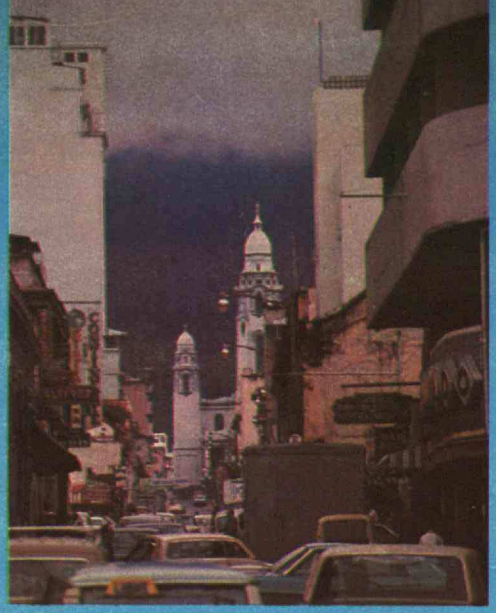
INSIDE PHOTOS: (1) Caracas Bull-ring (2) Macuto pool and beach (3) Caracas at night (4) Macuto and its Marina (5) Caracas by day (6) Another Macuto pool

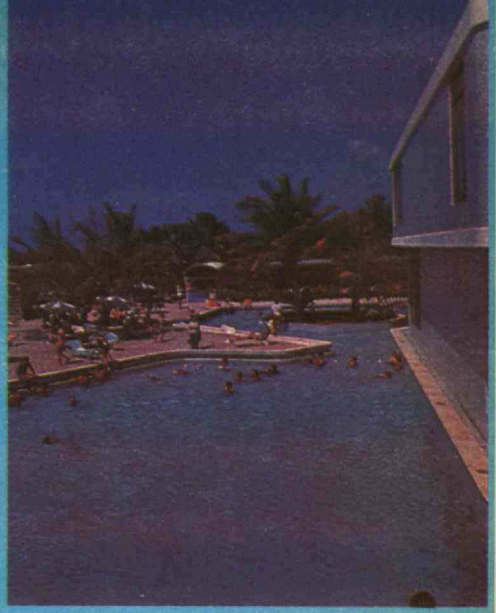
Our trip is planned to include:

* Round-trip Jet Flights between the city of departure in the United States and Caracas, Venezuela, via a large, four-engine DC-8 jet of VIASA, Venezuelan International Airways, the national carrier of Venezuela which flies regular service daily between the United States and Caracas. Complimentary food and beverage will be served aloft each way.
* On Arrival and Departure Deluxe Motorcoach Transportation for Persons and Luggage between Caracas' Maiquetia International Airport and our hotel, including porterage of luggage into and out of hotel rooms.
* A Venezuelan Welcome get-together, for the entire group on arrival featuring "Ponche Crema" (a popular Venezuelan drink). Hosted by our tour personnel, the gathering will give us a chance to make new friends and plan our activities.
* Hotel Accommodations for eight days and seven nights at the Deluxe (indeed the unbelievable) Macuto-Sheraton Hotel, in spacious, bright rooms all with double or twin beds, private bath and shower, air-conditioning, private telephone, television, music and contemporary furnishings. A complex of four buildings, the Macuto-Sheraton is best described as a resort city. Its facilities include three swimming pools, a 1500 foot white-sand beach, tennis, badminton, shuffleboard, a private marina, its own bowling alleys, its own theatre, skin-diving, deep-sea fishing, waterskiing, golf privileges at a nearby private club, several fabulous restaurants, a Supper Nightclub, cocktail lounges and bar, a huge shop-









n arcade, a health club, and full services includ- g oom service. Linked with Caracas by a twenty i ute cable car ride over the Avila mountains (or sea-side drive),the Macuto-Sheraton is located e edge of the Caribbean. As Sheraton's brochure y "When you travel to a magic land, stay at a a ce. We've got one!"

e kfast At The Hotel, each morning, consisting of e n danish pastry with tea or fantastic Venezuelan f ee, a lovely way to start each day.

H lf-Day Motorcoach Sightseeing Tour of Caracas, t English-speaking guide, will point out important g s such as *University City (with an auditorium by a nder Calder and modern art by Leger), Circulo M r (the Taj Mahal of Officers' Clubs), the n arian Museum (relics including a lock of hair o the head of George Washington), the Botanical a ens (the orchid is the national flower), the N o Circo bullring, the Parque del Este (a five h dred-acre paradise for children with, among h r things, a floating and boardable replica of C lumbus' flagship, the Santa Maria), the Plaza V ezuela entertainment quarter (favorite of the jet t , the Raul Santana Museum of Creoele Figures n ent Caracas in small figurines), The Transporta- o Museum (of vintage automobiles and coaches), e Museum of Colonial Art (Picasso, Moore, Calder, c the Humboldt Planetarium, La Rinconada r track (one of the world's most beautiful), the c edral (with art by Rubens and Murillo), the n nal Pantheon (the remains of Bolivar and h rs), Eighteenth Century haciendas, Los Caobos a (shaded by tall mahogany trees), El Silencio o Caracas), San Bernardino (the Jewish quarter), Sabana Grande (Indian and native handicraft shops), Avenue of the Leaders (really an Avenue of monuments), and much, much more . . . . . .*

* A Venezuelan Beef Dinner, one evening, our chance to sample world-famous Venezuelan steak including an appetizer of fresh tropical fruit and after dinner Venezuelan coffee.
* Admission and a complimentary rum drink at the Macuto-Sheraton's swinging El Torero Lounge, with live native music.
* A Complimentary Bowling String at the Macuto-Sheraton's own bowling lanes.
* A Criollo Music Hour, for the entire group, featuring live performers in native Venezuelan costume (Licki Licki), a chance to enjoy the magical music of this country.
* A Venezuelan Fashion Show, one day, to allow us to view (and buy) the colorful ponchos, leather goods, suede designs, belts, and bikinis typical to this region.
* Complimentary Tennis at the Macuto-Sheraton's "on the ocean" tennis courts.
* A Map of Caracas and a Guide to Caracas will be provided to each passenger upon arrival at the hotel, helpful information to facilitate our plans.
* The Services of Tour Host Personnel, well-informed people to advise and assist our group as we may require.
* "Tax and Service" is included in the trip, meaning all taxes and service charges (including one imposed by the Travel Agent) in connection with the included land arrangements in Caracas.

THE PRICE AND WHAT IT INCLUDES: The price shown on the front cover of this folder includes round-trip jet transportation (on charter flights) between the city of departure in the United States and Caracas, Venezuela, transfers of persons and luggage, on arrival and departure, between the Caracas airport and the hotel, hotel accommodations, on a double occupancy basis, for seven nights at the Macuto Sheraton Hotel or a hotel which, in the opinion of the Travel Agent, is equivalent in value to the Macuto Sheraton, a continental breakfast each morning, a half-day motorcoach sightseeing tour of Caracas, a welcome get-together for the group, such other group activities and tour features as may, in the discretion of the Travel Agent, be planned for the group, the services to the group of tour host personnel, and Tax and Service. The phrase "Tax and Service", as used in this folder, means and includes only the taxes and service charges (including one imposed by the Travel Agent) for the included land arrangements in Caracas. The constitution of the total price for this trip (air-transportation, land arrangements, and administration) and possible price fluctuations therefor are set forth elsewhere on the back cover of this folder. The items enumerated in the first sentence of this paragraph are expressed in general terms, because the Travel Agent expressly reserves the right, without having to refund any monies to the passengers, to alter, change, or make substitutions in the trip, its itinerary, and its features, provided that such alterations, changes or substitutions do not diminish the aggregate fair market value of what is to be included in the trip. The price of this trip does not include expenses of passports, items of a personal nature such as laundry, telephone, food and beverage other than specifically included, United States Airport Departure Taxes, currently $3.00 (for which taxes each passenger should be invoiced before departure), and any Venezuelan Airport Departure Taxes, or any other item not specifically stated herein to be included in the price of the trip.

SINGLE RESERVATIONS: The amount stated on the front cover of the brochure is per person based on double occupancy of a hotel room. Single reservations require an additional charge of $99.

DOCUMENTS: Each passenger is responsible for obtaining and having with him a valid U.S. passport and a certificate of Smallpox vaccination issued within three years preceding departure.

FINAL PAYMENT AND CANCELLATION: Payment of final balance is due sixty (60) days in advance of departure (at which time reservations will be confirmed). Regardless of when reservations are made, reservations may only be cancelled by written notice sent by registered mail (return-receipt requested) to the Travel Agent (For address, see paragraph entitled RESPONSIBILITY, ETC.). If such notice is received by the Travel Agent no later than sixty (60) days before departure, the Travel Agent will accept the cancellation and refund all monies, except for a $25 service charge per reservation being cancelled. If such written notice is received within sixty days before departure, the Travel Agent will accept such cancellation and refund monies (except for the $25 service charge) only if the cancelling party finds eligible substitute(s) for the reservation(s) being cancelled. Cancellation insurance (protecting against the loss of airfare) is available and recommended.

ELIGIBILITY: Participation in this trip is limited to those persons who, for six months preceding departure, have been members of the organization whose name appears on the front cover of this folder, such members' husbands and wives, their dependent children, and their parents, if living in their households.

LUGGAGE: Each passenger on board the aircraft is limited to 44 lbs. of luggage, subject to the further limitation that he have not more than one suitcase and one small carry-on piece. Throughout the trip, luggage travels strictly at the risk of the passenger, and the Travel Agent shall not be responsible or liable for any loss of, or for any damage to passengers' baggage (or its contents). Baggage insurance is available and recommended.

INSURANCE: Ordinary travel insurance is available.

RESPONSIBILITY, ETC.: Each person making reservations for or participating in the trip described in this folder understands and agrees to all terms, conditions, and limitations set forth in this folder including the following:

The air transportation for this trip is held out and engaged by the sponsoring organization whose name appears on the front of this folder, which organization acts as agent for the group of persons to be transported thereby. In endeavoring to make arrangements with various persons, firms, and corporations for the services and accommodations described in this folder to be included in this trip (or in any optional side trips offered in connection with this trip) International Weekends, Inc. (the "Travel Agent") 120 Water Street, Boston, Massachusetts 02109 acts strictly as agent for the air carrier in the case of the air transportation and as agent for the tour participants in the case of all other services. As an Agent, the Travel Agent shall not be responsible or liable for, AND EXPRESSLY DISCLAIMS ANY RESPONSIBILITY OR LIABILITY FOR, any loss, cost, injury, expense, or damage to person or property which results, directly or indirectly, from any act, whether negligent or otherwise, of commission or omission (including but not limited to delays), of any person, firm, or corporation which is to, shall, or does provide products or services in connection with the trip, including but not limited to transportation services (whether by air, sea, or land), lodging, food and beverage, entertainment, sightseeing, luggage handling or tour guiding or escorting. The Travel Agent reserves the right to decline, accept, or retain at any time and for any reason, any person as a participant in the trip (or any optional side trip). If any person is removed by the Travel Agent from the trip (or from any optional side trip) a proportionate refund for unused services will be made. The Travel Agent reserves the right to cancel the entire trip (or any optional side trips offered in connection with the trip) for any reason at any time before departure of the trip (or side trip respectively), in which event the liability, if any, of the Travel Agent shall be limited to and liquidated by refunding to each prospective participant the monies, if any, theretofor received by the Travel Agent for such person's trip (or optional side trip, as the case may be), which monies have not been or should not be otherwise refunded to him.

The terms and conditions of this trip may not be altered or modified without the express written consent of an officer of the Travel Agent.

OPTIONAL SIDE TRIPS

Here are a few of the optional side trips available for purchase:

A DAY AT ANGEL FALLS
Into the jungle for a visit to the world's highest waterfalls.

DAY IN TRINIDAD
Fly to this Caribbean Island for a day of sightseeing.

MARGARITA ISLAND
Fly to the island of world-renowned pearls.

JUNGLE BY HORSEBACK
An exciting ride by packhorse including a river bath.

DAY AT THE RACES
Lovers of the sport of kings will enjoy a day like one.

NIGHTS ON THE TOWN
A variety of nightclub tours to the best of Caracas.

DAY IN MARACAIBO
Fly to Colombia for a day of sightseeing.

****The price of this trip is constituted as follows:**

New York
Air transportation, $151.12 per person; land arrangements, $189.73 per person; administration, $3.00 per person; total price, $343.85 per person. Boston: Air transportation, $164.71 per person; land arrangements, $176.14 per person; administration, $3.00 per person; total price, $343.85 per person.

The airfare stated above is the pro rata cost to each of 195 passengers. Should there be fewer than 195 passengers, each passenger may be notified of any increased pro rata cost to him, and will have the option to pay the difference or cancel without penalty.

The cost of the trip is based on the monetary exchange rate of U.S. Dollars to Venezuelan Bolivars as existed on June 1, 1975, and on tariffs, rates and costs in effect as of June 1, 1975. Should there be, between then and the date of departure, a change in such exchange rate unfavorable to the U.S. Dollar, an increase in such tariffs, rates or costs, each passenger may be required to pay an increased amount for the trip reflecting such increase.

FINAL RESERVATIONS DEADLINE

Jan. — Nov. 14
Feb. — Dec. 11

THIS WAY TO CARACAS

TO: Bob Radocchia
M.I.T. 50-356
77 Mass. Ave.
Cambridge, MA 02139

MY CHECK IS MADE PAYABLE TO:
M.I.T. Quarter Century Club

Check one:
New York, Feb. _____
Boston, Jan. _____

Enclosed is $_____ ($100.00 per person) as deposit for _____ reservation(s) on the Caracas trip, subject to the terms stated in this folder.

Name(last) _____ (first) _____

ADDRESS _____

CITY _____ STATE _____ ZIP _____

TELEPHONE(9-5) AREA CODE____ NUMBER_____ (after 5) AREA CODE____ NUMBER_____

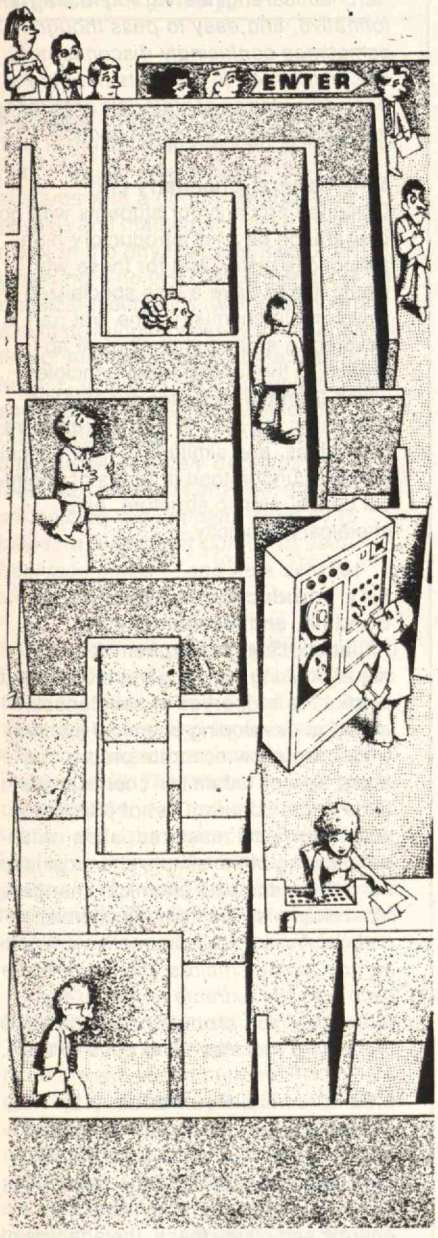
☐ I REQUEST A SINGLE ROOM ☐ I REQUEST A DOUBLE ROOM TO BE SHARED WITH

_____
(Name & Address)

CRC 114;211-MITT

I have attached a list of names, addresses, and telephone numbers of those persons for whom I am requesting reservations, and have indicated whether single or double accommodations are required.

Institute Review



A student view of a freshman's first week at M.I.T.: while dead ends and computers abound, there is a route through rushing and orientation to the goal of registration. (Drawing: R/O Week Friday)

Largest Freshman Class in History Tackles M.I.T.; a Bewildering Array of Courses, Activities

The decision to come to M.I.T. — 1,100 freshmen made that decision this year — is the big one. But it opens a Pandora's box of literally scores more questions — and most of them have to be answered in the two-week period which spans August and September: What to study? Where to live? What courses to take? How much time for *The Tech*? What about a "language house"? Alternative programs? Some different mode of instruction? Freshman seminar? Undergraduate research? How many units to take? Advanced standing? Try out for the cross-country team? Need a MITHELP module? Sign up as a preprofessional (law, medicine, education)? R.O.T.C.? Take a course at Wellesley?

The *Freshman Handbook* calls R/O ("residence/orientation") Week (August 29 to September 9) the "free extravaganza week. Don't miss the great chance to meet everyone you want and get a feeling for the places you're interested in." And to help freshmen relax, it urges that "there is no way to make perfect choices; be content if you've made good ones."

Hundreds of Courses: How to Choose?

There are five different ways for freshmen to meet the 12-unit chemistry/biology requirement; ten different courses in mathematics; eight different courses in physics for first- and second-term freshmen; and 68 humanities courses — in anthropology and archaeology, creative writing, foreign languages, history, history of art and architecture, English and foreign literature, music, philosophy, political science, urban studies, visual arts and design, the Western tradition, technology studies, and American studies — approved within the humanities distribution requirement, toward which freshmen are advised to start.

Registered for a normal share of chemistry, physics, mathematics, and humanities, a student will find himself committed to just under 80 units in the first year. A normal first-year load is 90, which leaves some uncommitted time. To help freshmen fill it, Dean Peter Büttner includes in his *Freshman Handbook* a list of just over 150 courses which have no prerequisites and are given outside the Department of Humanities primarily for undergraduates. And there are some 100 courses in humanities and philosophy for which there are similarly no prerequisites. (The most popular freshman electives are the introductory computer subjects — Information Systems, Elementary Programming, Computer Models, Introduction to Computation and Management Information Technology.)

There are also undergraduate seminars — nearly 70 of them — which offer "a more relaxed, informal atmosphere with a good deal of interaction among faculty and students." And a chance to become involved in research through U.R.O.P., the Undergraduate Research Opportunities Program.

A MITHELP module? If you find first-year mathematics (for example) a little too hard, you can sign up for some review or remedial work in the form of a module: two one-and-a-half hour evening sessions a week for two or three weeks put on by the Freshman Advisory Council. Modules in mathematics and general study skills are the most popular.

A few freshmen, to whom all this sounded heterogeneous, signed up for "Concourse" or the "Experimental Study Group" — efforts by a few faculty members to create smaller groups in which learning occurs more informally. "Concourse" tries to interrelate the Institute requirements in physics, mathematics, chemistry, and humanities into a single interdisciplinary study — this year "Mind, Machine, and Meaning." Subtopics: computers, artificial intelligence, neurophysiology, the mind-body problem, perception, and communication theory.

The Experimental Study Group is the same theory though different in practice. It's an experiment "with styles and modes of study which are not rigidly constrained by the traditional structure of scheduled lec-

tures, recitations, problem sets, and tests." Students study regular courses with faculty in E.S.G. With everyone working together students have "wide latitude in deciding when and how they do their learning. . . . Small seminars and interest groups spring up and do their thing. . . . Music and chess are played, set theory studied, and computers built around the clock."

Over-Registering, Pass/No-Credit, and What if You Can't Find Your Adviser

With so many alternatives, how can anyone choose at all? The *Freshman Handbook* suggests one way: over-register. Sign up for 60 or 70 units (the normal load is 45) for the first term, attend everything for several weeks, and then drop the courses which seem least promising (subjects dropped before the end of the fifth week of the term appear on no records at all). Many students do it, and the *Handbook* says "the system seems to have enough capacity." But a word of warning follows: "Over-registering tends to degrade the quality of scheduling." And freshmen are asked to "limit themselves to a reasonable total number of subjects."

Pass/no-credit grading (see pp. 89-91) also helps students who are simply unable to keep from getting into a little of everything. The *Handbook* quotes one freshman: "It doesn't mean that you don't have to study: it just means that you don't have to get too worried about not doing A-work all the time. You get a chance to do things besides studying." Another said, "Pass/fail is a safety valve to keep your grade-grubbiness and pride from driving you crazy." Dean Büttner's advice to freshmen in the *Freshman Handbook* is to work hard and not to worry:

"There is the basic assumption that you will want to make the most of your educational experience in M.I.T., from which follows the implicit expectation that normally you will want to derive the most you reasonably can from each subject you take. To do this effectively, most of you will find you need to make an early commitment to keep up-to-date in all aspects of each subject — the reading, written exercises, classroom participation, evaluation procedures, and whatever. You may be able to get by with less, but you may also then feel you haven't quite got your money's worth for the time that's gone by. Another point is worth adding: few students have found catching up to be an easy process at M.I.T.; last-minute efforts aren't always successful.

"Under the A-F system it was usually a good guess as to where you'd come out in the end, but with pass/no credit it's much easier; if you've been reasonably conscientious about fulfilling the requirements you should expect to pass, while if you've neglected them it may be a different story. And of course if you get turned on about a sub-

A Prize for "Blasting the Awesome Image"

M.I.T.'s record-sized Class of 1979 was attracted to the Institute by a prize-winning communications program, ". . . a comprehensive and complete set of communications materials which are clean, orderly, and graphically coordinated."

The quotation is the statement of judges who awarded the Institute a $1,500 first prize in a Communications Award Program administered by the College Entrance Examination Board and the Council for the Advancement and Support of Education and sponsored by Aetna Life and Casualty Co.

Entering the competition, the Institute said its philosophy was to present "a complete picture of a complex institution while meeting the diverse information needs of our prospective students." The entry was prepared by Kathryn Lombardi, Manager of Campus Information Services, and Janet Snover, Production Manager of the M.I.T. Bulletin, and it included the *General Catalogue*, the *Courses and Degree Programs* Bulletin, *Thoughts on Financial Aid*, *M.I.T. Today*, *M.I.T.: A Place for Women*, the "Freshman Handbook," "Undergraduate Residence," and application forms for admissions and financial aid.

Students and counselors judging the entries agreed that M.I.T.'s materials were "thorough, complete, informative, and candid," says C.A.S.E. One student judge used the words "basic" and "solid." Another commented, "No gimmicks, no glamour, but lots of straightforward information. . . . Blasts the awesome image into enough little pieces that a prospective student could manage it."

The $1,500 prize money has been added to M.I.T.'s general scholarship fund. □

If you remember when every M.I.T. freshman signed up for the same program — 5.01, 8.01, 14.01, and 18.01 — to meet the basic requirements in chemistry, physics, humanities, and mathematics, forget it. Though the requirements stand, the choices today are legion. To the right is the list of subjects to fulfill the science (chemistry, physics, and mathematics) requirement with excerpts from descriptions in the 1975 Freshman Handbook *and (in italics) student comments from the Technology Community Association's 1975 "Course Evaluation Guide." Why so many options when one course used to serve everyone? Because, says Peter Büttner, '61, Associate Dean for Student Affairs, freshmen come to M.I.T. from many backgrounds and for many different reasons; and because M.I.T. intends that it serve its freshmen with the best possible education for their abilities and needs.*

Science Requirement: Chemistry/Biology (12 units)

3.091 Introduction to Solid-State Chemistry (12)
Special emphasis on structure-property relationships. Atomic structure, chemical bonding, crystal structure, thermodynamics and the reactivity of materials, single and multiphase systems. Particularly attractive and helpful to students interested in electrical, mechanical, and aeronautical engineering. *Interesting, informative, and easy to pass though sometimes confusingly disconnected. Recommended to students needing a basic knowledge of materials or to those not interested in organic chemistry.*

5.40 General Chemistry (12)
Designed primarily for students with no preparation beyond introductory high school chemistry, and for those who would like to have a less specialized viewpoint in chemistry. The first part is devoted to a phenomenological approach to the fundamental principles which form the basis for quantitative chemistry; the second part to trends, relationships, and similarities in chemical behavior understood in terms of chemical bonds, atomic structure, and chemical periodicity.

5.41 Introduction to Structure, Bonding, and Mechanism (12)
An introduction to the chemist's technique of using simple generalizations to predict the properties of substances, aimed at developing chemical intuition which can allow accurate predictions about new or unfamiliar chemical systems and a coherent set of principles which, correctly mastered, allow an understanding of the simple chemical laws behind the complex chemical changes. Most examples are from the chemistry of carbon. *A must for prospective chemistry and biology majors; the major criticism was the extreme length of the quizzes, which probably contributed to the feeling that they were quite difficult.*

5.60 Chemical Equilibrium (12)
The equilibrium properties of macroscopic systems and the laws of thermodynamics, especially the state functions of enthalpy, entropy, and free energy; and, using these, the analysis of such chemical problems as heats of reaction, vapor pressure of condensed phases, colligative properties of solu-

tions, and chemical equilibrium. Calculus is used extensively.

7.01 General Biology (12)
An intensive study of biochemistry, particularly biosynthetic processes; genetics; developmental biology; and physiology. Freshmen should consider this subject only if they have a solid background of chemistry in high school. *The scope of the course focuses more on molecular biology than on physiology or botany (descriptive biology). Exam questions were hard, tricky, and strictly graded.*

Science Requirement: Physics (24 units)

8.01/8.02 Introductory Physics (24)
This is the standard sequence for freshman physics, a natural first choice for students with a good background in physics and mathematics who expect to major in the physical sciences or engineering. The first half concentrates on classical mechanics, with the important aim of developing fluency in the application of mathematics to physical problems. Calculus is used sparingly. The second half is devoted to electromagnetism. *How people feel about this course definitely depends upon their background in physics; 8.01, being an Institute requirement, must try to please a significant portion of each freshman class — and thus satisfies almost no one.*

8.011/8.021 Introductory Physics (24)
For students who do not plan to go into fields that require more than a broad view of physics, and those who do not expect to take more than one year of physics in all. The whole range of physical phenomena is treated in a manner that emphasizes conceptual understanding rather than mathematical analysis. *A good physics option for those not mathematically inclined; for anyone who won't need any physics for his future work.*

8.012/8.022 Introductory Physics (24)
The same subject matter as 8.01/8.02 but more advanced mathematically; the general level is designed to be quite challenging with an emphasis on working fairly difficult problems. *If you have a good math or physics background and are interested in physics, this is the course for you. It is undeniably demanding; the problem sets are long and tough and are the only way to learn the material.*

8.013/8.023 Introductory Physics (24)
About the same level of difficulty as 8.01/8.02 but with particular emphasis on topics relevant to biology, biophysics, and biomedical research and engineering; developed under the auspices of the Joint M.I.T.-Harvard Program in Health Sciences and Technology. A rigorous subject in physics for students who intend to to pursue careers in the life sciences. *Very rigorous and uses calculus liberally. The problem sets were really hard and appeared every week, including vacations.*

Science Requirement: Calculus (24 units)

18.001/18.002 Calculus (24)
This course starts from scratch and assumes only a knowledge of algebra and trigonometry; it is a unique calculus course created to provide a working knowledge of calculus that will satisfy present and future professional needs. An intensive and comprehensive development of calculus that is more applied and less theoretical than any other option; theory is developed only to the point of optimum return. *Most people who took the course enjoyed it, although many felt that prior exposure to calculus would be very helpful for a course of its depth and fast pace. More practical and with more applications than 18.01/18.02.*

18.001E/18.002E Calculus (24)
Intended for students with a fairly extensive background in calculus — especially in differentiation. 18.001E lasts about six weeks — until the end of October; it is followed by 18.002E, which ends about six weeks into the spring term. It is recommended that students in 18.001E/18.002E register for 18.03 (Differential Equations) in the spring term. *The pace is very fast, and many students would have preferred to slow down a bit; they warn freshmen, especially, about the amount of work involved here. Knowledge of basics is assumed, and good high school preparation, including thorough work in differential calculus, is necessary for this course. As with most applied math courses, theory and proofs were glossed over or omitted. A good course for those who are willing to work hard and enjoy a challenge.*

18.01/18.02[1] Calculus (24)
A traditional calculus course adapted for the needs and abilities of M.I.T. students; for example, it takes advantage of their generally high mathematical aptitude by moving much more rapidly than similar courses in other schools. They will need a high level of competence in using calculus, and the examination system is designed to help them acquire it. 18.01 covers differentiation and integration of functions of one variable; 18.02 is a combination of elementary linear algebra, functions of several variables, and vector calculus. There is no time for a detailed account of theory, though most theorems are either proved or an explanation is offered which could easily be converted into a rigorous argument. We try to guard against being too superficial by sticking to this rule: no topic can be introduced unless it is developed in enough detail for questions to be asked about it on an exam; everything in the course will be tested in one or more of the exams.

18.01B[1] Calculus (12)
This version of 18.01 lasts ten weeks; it is for students who enter well prepared with standard topics in differentiation and its applications.

18.01C/18.02C Calculus (24)
A special rapid version which covers the whole content of 18.01 in six weeks; the first half of 18.02 follows in the second half of the first term, and the balance of 18.02 can be completed during the Independent Activities Period in January or during the first half of the second semester. Topics in differentiation and integration are reviewed very quickly; don't take 18.01C/18.02C unless you have a strong calculus background.

18.01X Calculus (12)
This is a slower version of 18.01 being offered this fall for the first time. Consider registering if you have had no prior experience with calculus, and if your College Board math scores are low compared with the average of entering freshmen.

[1] *Students in 18.01, 18.01B, and 18.02 will have their choice of two alternative examination systems. In either case, the material of the course will be divided into units, and each student must pass an examination on each unit. In the conventional examination system, there will be optional one-hour tests given at intervals during a lecture hour.*
For students electing the alternative, "self-paced" examination system, a slightly shorter test will be given in a special room for several hours each day. The test will be graded immediately by a tutor assigned to the room in consultation with the student, and if the student fails he must later return and take a test on the same unit again. There will be deadlines for passing each unit.

New Houses: Beacon Street on Memorial Drive

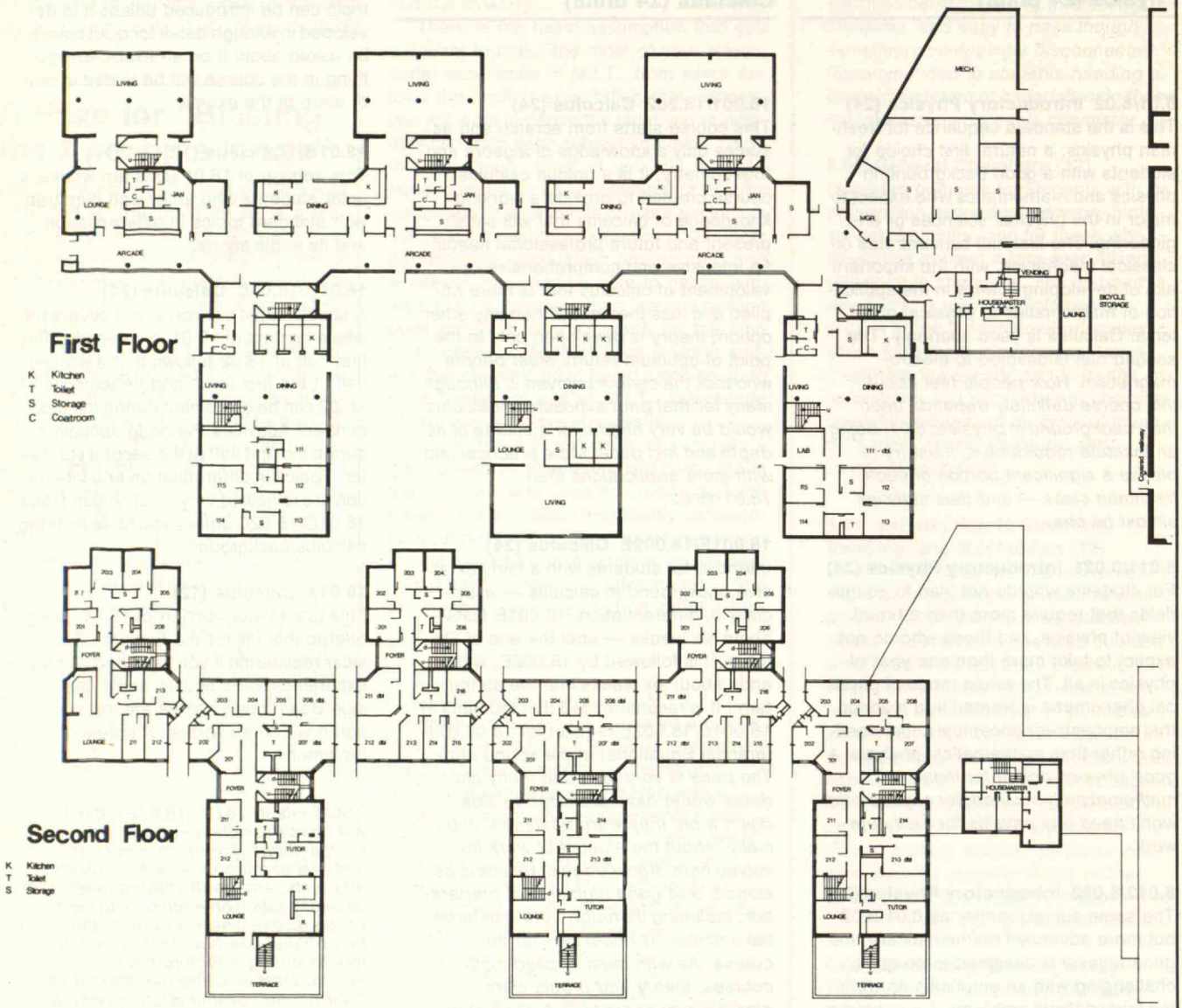
The largest freshman class in M.I.T.'s history is made possible by the completion of a new Institute House, facing the river west of MacGregor House. Still nameless, it's called the New West Campus Houses — in reality a series of entries forming a series of small houses all under a single roof. Resident interaction . . . personal and intellectual growth . . . transience . . . variety . . . change . . . homogeneity — all these are among the adjectives which the M.I.T. Planning Office uses to describe the goals, objectives, and lifestyles which it hopes the New Houses will reflect and inspire.

The new brick building, being completed just in time for its 300 occupants' arrival early in September, seeks a "homey" atmosphere similar to that found in the fraternity houses along Beacon Street.

To create that atmosphere, the Planning Office, under the supervision of Harry P. Portnoy, Senior Architect, decided upon six separate five-storied units with the emphasis not on suites but on individual units of 50 students. To further underline this vertical integration, 19 kitchens were placed on various levels throughout the six units, mainly in groups of two and three. Although each kitchen can serve only eight to ten people, the dining areas nearby are large enough to accommodate several groups for communal meals or dinner parties.

Linking the six units, all of which will be all-men with the exception of French, German, and Russian Houses, is a ground floor arcade, the "Beacon Street" of the New Houses, containing vending machines and laundry facilities. Also along this arcade are the entrance to the housemaster's apartment, a completely enclosed bicycle storage room, and a covered walkway to MacGregor House.

The New Houses were designed by Sert Jackson and Associates, Cambridge, with the Turner Construction Co. as contractor; the total project budget was $5.4 million. □



A single, central arcade links six separate "houses" within the New West Campus Houses which were completed in time for student occupancy this fall. The Planning Office designers liken the arcade to "Beacon Street" linking six "fraternities." There are living and dining rooms and kitchens on the first floor (lower drawing), single and double rooms (and occasional informal living rooms) on four upper floors, a typical plan of which is shown in the upper drawing. An undergraduate who toured the Houses last spring told The Tech *he "liked it. The rooms are very nice," he said; only one problem: "Five floors but no elevator."*

ject and really get into it, then you might just as well forget about the grade and enjoy the material."

An earlier freshman, quoted in the *Handbook,* confirms this advice: "The work at M.I.T. is tough. Sometimes it's exhilarating, sometimes unbearable. Usually it's somewhere in between. The only thing you can be sure of is that if you want to learn, this is the place."

For help with all these decisions, freshmen turned to their faculty advisers with every imaginable question. But that, said the Freshman Advisory Council, was not the main point of the system. "The primary role of the adviser," says Dean Büttner who runs the F.A.C., is "simply getting to know a few freshmen well."

His instructions say, "You should consider yourself first of all a concerned adult, sensitive to freshmen and their environment and interested in helping each of your students gain the maximum benefit from the M.I.T. experience. . . . Mutual confidence and trust . . . are prerequisite to the exchange of attitudes, ideas, style — and problems."

The importance of the adviser is made clear by the student's suggestions in the *Handbook*: "If you can't reach your adviser when you need him/her, get another."

Getting In and Sorting Out

The sorting process which brought 1,100 freshmen to M.I.T.'s Class of 1979 this fall began about a year ago, when a total of 8,087 "preliminary" applications — requests for information and indications of interest — had been logged by the Admissions Office. These resolved into 4,546 final applications from secondary school students — 3,893 men and 658 women — of whom just over 2,000 were admitted, including about 85 applicants originally placed on the "waiting list" last April.

The R/O Week registration suggests that some 54 per cent of all those granted admission to M.I.T. elected to come to the Institute. That's almost precisely the "yield" in 1974. The Class of 1979 includes some 175 women — down from over 200 in the Class of 1978, and Peter H. Richardson, '48, Director of Admissions, admits he is disappointed — and about 40 minority students.

But of the Class as a whole, Mr. Richardson waxes almost poetic: "The variety of attractive young men and women who keep showing up on our doorstep is amazing to me," he says — "just fabulous people." — *J.M.*

Housing: Lots of Variety, and If You're Not Satisfied "You Haven't Looked Hard Enough"

Where to live at M.I.T.? The first — and not the least — of the decisions awaiting members of the Class of 1979 when they arrived in Cambridge on August 29.

Freshmen who do not live at home, or with close relatives, must live "on campus" — a term which includes 40 different housing alternatives: eight on-campus Houses, three on-campus language houses, 28 fraternities, and one "cooperative" house. That's a big range of choice, and Dr. Carola B. Eisenberg, Dean for Student Affairs, admits it's "an important decision."

But her advice to freshmen is "not to get up-tight about it — to keep some perspective. The issue is not that of finding *the* one living group where you will be able to exist, but of finding one of the many in which you will be happy and comfortable."

There's "undreamed-of variety," say Mark Suchon, '76, and Gregory Blonder, '77, Chairmen respectively, of the Interfraternity Conference and the Dormitory Council, "If you do not find what you like, you have not looked hard enough."

Coed living? Your choice of ten living groups — four on-campus Houses, all three on-campus language houses, two "fraternities," and the "cooperative." It's "a normal way of life" for many students, increasingly successful since its introduction six years ago, says the "Undergraduate Residence" handbook for 1975. But to freshmen who may be uneasy about the coed situation, the handbook offers assurance that "single-sex living groups are hardly monastic." Each group is expected to make its own rules about visiting by members of the opposite sex, and "they may be — and often are — present at all times." If there are problems, they are in the jurisdiction of the house government.

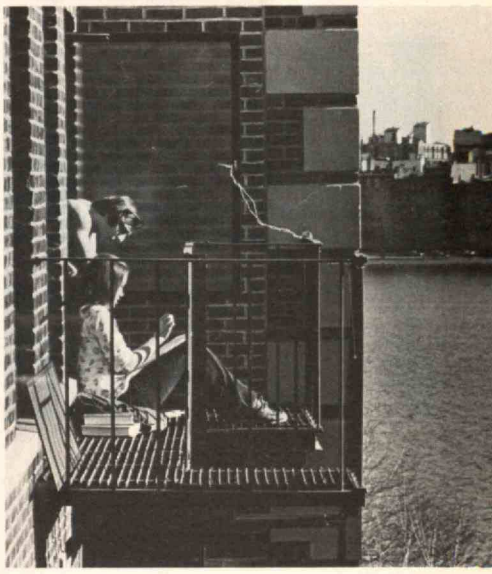
Pets — "mammals, birds, and reptiles" — are prohibited in the Institute Houses, and "it is planned to strictly enforce this rule."

"*On parle français ici*," write two members of French House, which occupies one floor of New House (see box). But "*il ne faut pas toujours parler français; si on discute des sujets techniques on peut le faire en anglais.*"

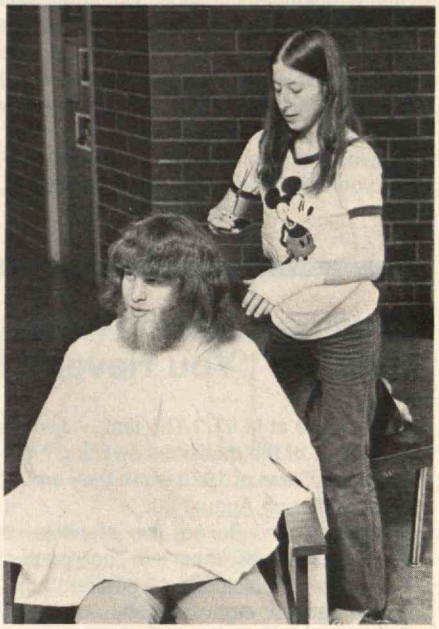
Fraternities have their own ways of characterizing themselves in the handbook: "A pack of cretins with a 4.3 house cum.," writes Pi Lambda Phi. "Beneath the cool exterior of our house lurk the subtle dynamics of a nursery school class," says Pi Kappa Alpha. "We entirely reject the idea that freshmen should do more than their share of the work," insist the members of Chi Phi.

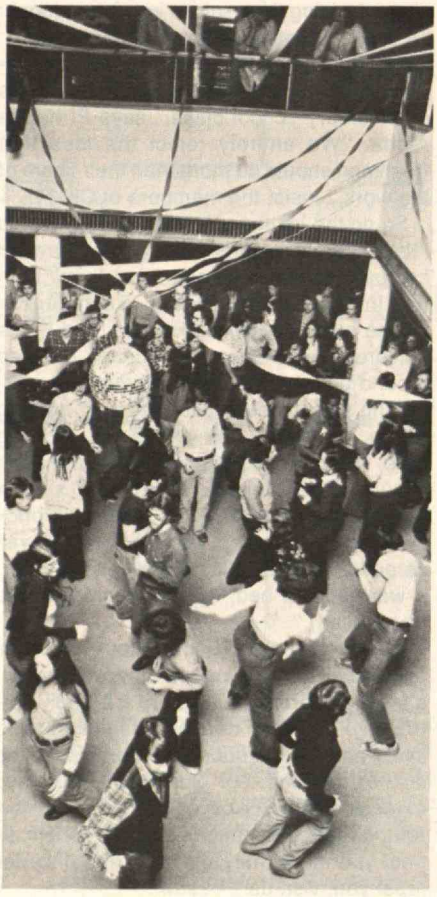
So do the Institute Houses. Bexley Hall is "the most convenient living structure on campus . . . just a stoned (*sic.*) throw from the Institute's front door." Each Burton House suite includes a kitchen, and if this conjures "an image of Burtonites huddled around boiling cauldrons, stirring and murmuring solemn incantations to their frothing meals, . . . that's part of the fun of living here." MacGregor paints an especially posh picture: "The average room is 9′6″ x 13′ x 7′8″ . . . has a wall-to-wall window, a brick wall, and a wooden wall . . . wall-to-wall carpeting, a desk, a lamp, a tilt-swivel chair, a wardrobe, a bed, and a concrete waffle (the ceiling)."

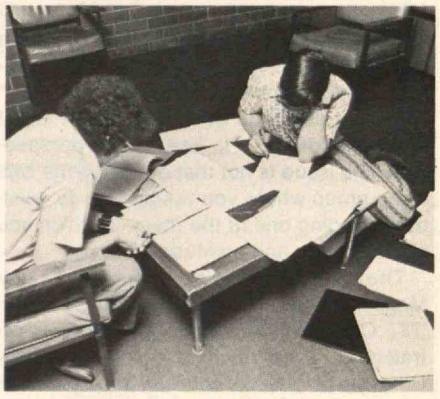
And then there's Senior House: "Some people call it a working anarchy, some call it a loafing anarchy; but we are a friendly matriarchy. . . . Our heating system banged every hour on the hour all winter; it's a good way to tell time. . . . Our telephones have extensions Ma Bell never heard of. . . . If low rent, large rooms, age, life, and freedom attract you more than age, dirt, and disorder repel you, visit us." — *J.M.*



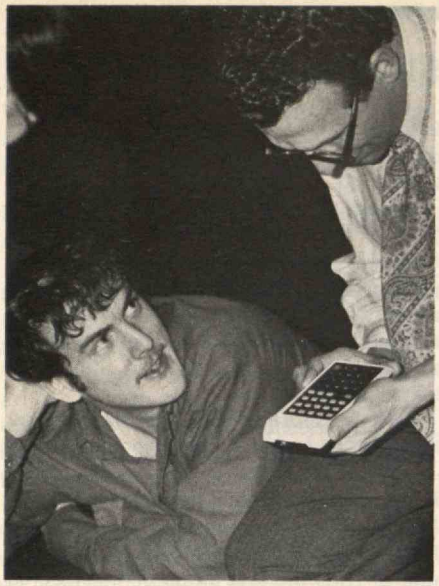
What will the next four years be like for a freshman entering M.I.T. with the Class of 1979? An unanswerable question, but the pictures on this and following pages may provide some clues for those who choose to live in Baker House (top and page 86) and Burton House (below and page 87). The editors assume that further identification is unnecessary.

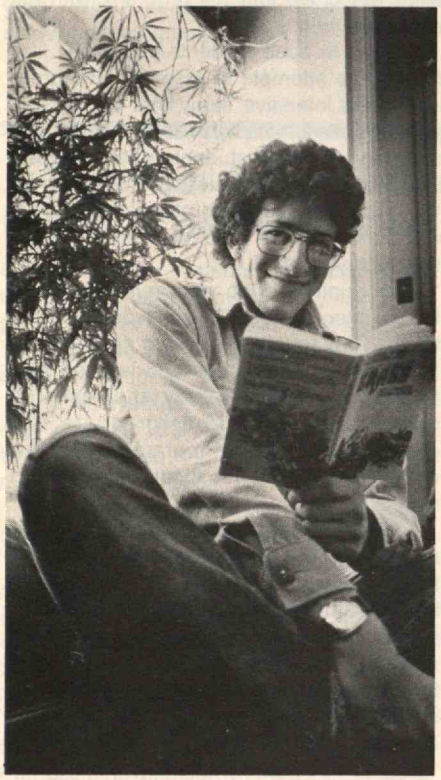






Baker House photos by Thomas F. Klimowicz, '77, from The Tech.





Burton House photos by David H. Green, '75, from The Tech.

Though the outside hardly looks different, the inside of Delta Psi's "Number 6 Club" at 428 Memorial Drive is refurbished to the tune of $640,000. Most of the money is a loan from the Independent Residence Development Fund, accumulated by M.I.T. from gifts to the Alumni Fund for just such purposes as Delta Psi's.

Delta Psi's Old Fraternity House Has New Interior

Last fall Delta Psi Fraternity was thrown out of its house by workmen. It was a happy eviction — they would return to a recycled house in August, 1975.

The problem became evident five years ago: if they didn't do some fast maintenance work their charming 60-year-old house at 428 Memorial Drive would deteriorate beyond repair. But to renovate without adding more living space would raise room and board too high. The solution: renovate and expand. Now the plan is complete.

"We tried to maintain and renew the best spacing and detailing of the old building, while providing student accommodations comparable to the newer Institute dormitories," said Kevin O'Keeffe, '71, the designer. (Mr. O'Keeffe is a Delta Psi alumnus working with Applied Design, Inc. in Brookline.) The new interior, expanded to house 48, includes an additional floor in the main house and two new floors in the annex, new gas-fired hot water heat, new plumbing, wiring, double-glazed windows, fire prevention and safety features. The designers provided for coed living (17 of the house members are women) with two bathrooms on each floor. Plumbing arrangements will allow the fraternity to convert to suite arrangements with kitchenettes if they desire.

The bulk of the $640,000 project will be funded through a long-term, low-interest loan — up to 40 years and as low as 3 per cent — from the Independent Residence Development Fund. This special Institute fund provides loans to independent living groups for building or improving their housing. Contributions to this fund must be specifically designated by the donor. Since its inception in 1964, it has raised $1,300,000.

But Jack Danforth, '40, Chairman of the Building Committee, stresses that additional funds are needed for the fraternity; he is working to raise money through direct contributions from Delta Psi alumni.

Cost per student of approximately $13,000 (the total project costs divided by the number of students accommodated) compares very favorably with M.I.T. new dorm costs. Inevitably, student rent will rise, but "we expect other fraternity costs to come up to our level and eventually go higher," said Kenton C. Murphy, President and Summer Manager.

Delta Psi has a long history. Since 1889, they were called the Number 6 Club (their old home was at 6 Louisburg Square in Boston, and the name stuck). When M.I.T. moved across the Charles, so did they. By 1915 construction was completed for their new home — to house 18 — at the present location. In 1946, an annex was added to expand capacity to 30. Now, the old Back Bay style exterior conceals a brand new inside. — *M.L.*

Starting Out Right

Late summer nights studying problems in calculus, physics, and chemistry? By choice, not by necessity?

Indeed, this was the decision of 25 members of the entering freshman Class of 1979. For six weeks during the summer they participated in Interphase — an intensive academic program to sharpen the mathematical, technical, and verbal skills of students with weaknesses in their high school education.

It was in 1968 that M.I.T. first made efforts to recruit and admit more minority students — and in response to a proposal of the Black Student Union developed the Interphase program to ensure the success of these students once admitted. In the summer of 1969 the first group of 44 students were welcomed into the program, with full expenses paid.

Geared to ease students into M.I.T. life, Interphase attempts to resemble the pressures and intensive study that can be expected during the school term. From early morning on, these students dash between courses in math, physics, writing, chemistry, study skills, art and photography. This will earn them 18 elective credits toward their first year at M.I.T.

Opportunities to do work related to their field of interest at M.I.T. is included in orientation. They toured the Draper and Artificial Intelligence Laboratories and learned how to obtain grants for study and research through U.R.O.P. (Undergraduate Research Opportunities Program), and interviews were set up for those interested in medicine.

Freshman year can be a rude awakening, and the erosion of a positive self-image for these students is critical. "No one knows better than these students just how incompatible high school ego notions can be with university demands of timetables and professors' expectations," Mary O. Hope, Assistant Dean for Student Affairs and coordinator of the program, told *Tech Talk*. "They've been so accustomed to being top students in their home towns, that they need to break down false ideas about achieving and build up skills that will be essential to them with their better prepared peers," she explained.

The effect may be as much psychological as academic. Jim Gates, '73, who participated as a student in the first Interphase program seven years ago and is teaching physics in this year's program, thinks that the head start he gained from training in basic skills helped more to build necessary first year confidence than to bridge gaps in his education. Mr. Gates went on to receive his S.B. in physics and mathematics and is presently a second year graduate student in physics.

It is not surprising that the reinforcement of career goals is an important facet of Interphase. Already, these students are res-

olute in decisions to go into engineering, physics, architecture, and medicine. Stanley Anderson, '79, of Chicago, became interested in engineering through his participation in an introductory program to engineering for high school students at the Illinois Institute of Technology, similar to one conducted at M.I.T. this summer (*see page 94*).

Though many students have selected their area of study, "many change midway though the year because of misconceptions they may have had," said Dellonia Watson, '78, a student in last year's program who is a tutor in expository writing for this year's Interphase. "The primary function of a tutor is to follow up on students' progress during the year," she said.

There are literally no disadvantages to Interphase, according to Dellonia; it is one of the best programs at M.I.T., she says, and we're trying harder to make it better every year. "Which means making it harder," one student added grimly. — *S.F.*

Must M.I.T.'s doors be closed to high school students whose education may have been less challenging than it should have been? Twenty-five such students came to Interphase this summer to sharpen their skills in preparation for the freshman year.

A Two-Year Study of Grades and What They Measure: "Feeling Good about Learning" is Better Than an A, Even an A+

College grading systems are multipurpose devices to record students' progress, compare students' abilities, stimulate students' learning. Can any one system do all these disparate things?

And, on average, the grades given to college students are rising — at M.I.T. and everywhere else; the change is enough to make "grade inflation" a national issue in higher education. But how serious is the trend toward more As and few Fs?

After a year (1973-74) of analysis by a special faculty committee and another year (1974-75) of sometimes bitter debate on that committee's recommendations, M.I.T. begins operating this fall under a new set of faculty rules on grades and registration. They can hardly be called revolutionary, but the committee headed by Roy Kaplow, '54, Professor of Metallurgy, thinks its recommendations as adopted by the faculty will have significant if subtle benefits for the educational process and for the students engaged in it.

After its two years of work, the committee concluded that there is "a relatively low understanding of grading," says Professor Kaplow. Indeed, he says, little is known about how grading affects education or the futures of the people being judged.

What is a proper measure of education? A measure "of good things happening," of "people feeling good about learning," thinks Professor Kaplow. Even at best, grades are not really a measure of such subjective impressions.

What about grades as a factor in competition? Students at M.I.T. "feel themselves to be part of a highly competitive situation," said the committee, and emphasis on grades contributes to that sense of intense rivalry. But "many people feel much better about themselves and their lives when they do not have to compete," and sociological studies convinced the committee that learning is best done in an environment of cooperation, not of competition.

Grade Inflation: Half the Grades Are As

The trend of grades at M.I.T. is up; during three terms of 1973-74, 51.5 per cent of all grades given were As, while a decade earlier only 28 per cent were As. "No doubt the grade inflation was one of the issues" motivating the Committee on Educational Policy to commission a study, Professor Kaplow thinks. (He heads the committee assigned that study.)

The committee found itself only modestly concerned. True, "whatever usefulness a grade has disappears if everyone has the same grade," Professor Kaplow admits, and good grades are "one of the few currencies we have for rewarding good performance." But the growing number of good grades given at M.I.T. may, in fact, correlate directly with the improving quality and performance of its student. Extrapolating from the distribution of scores of students entering M.I.T. on College Entrance Examination Board tests, Professor Kaplow and his colleagues concluded that 55 per cent might be expected to qualify for As, another 30 per cent for Bs, less than 4 per cent for Ds. Thus, said the committee, "there is no clear evidence that the distribution of grades actually differs significantly from the distribution of students' abilities to handle M.I.T. subjects, overall."

The committee finally concluded against "a concerted Institute-wide effort aimed at a more 'normal' grade distribution." But to increase the faculty's opportunity to discriminate between the many students deserving of As, the committee proposed a formal mechanism for brief, optional "comments" attached to grades. Such comments would give a "multidimensional" evaluation, said the committee, in which the faculty could suggest the nature of each student's abilities or the source of the recorded high performance — preparation, interest, effort, innate intellectual ability, etc.

And the committee took comfort from what Professor Kaplow called "its intuitive feeling that the discussion will tend to slow grade acceleration by making the faculty more aware of what they are doing."

A, B, C, D, P, F, I, O, OX, J, S, and Now T and NC

Among all the grades that can be given at M.I.T., four represent acceptable performance in graded subjects: A, B, C, and D. The faculty agreed with the committee that this was enough, A being defined as "passed with honor," B as "passed with credit," C "passed," and D "barely passed." Some of the committee, and a vocal minority of the faculty, called for more options — plusses and minuses attached to each of the four letters; an A+, they said, would designate the small group of A students who do "truly superior" work, for example.

The faculty voted nay, accepting the committee's view that such grades would give "an unwarranted appearance of accuracy" to the grading process and increase "grade pressure."

The grade of F has traditionally been used at M.I.T. to record "failed — no credit awarded" situations. The committee wasn't sure. Given the quality of M.I.T. students, "failure for intellectual reasons" is "virtually non-existent"; and so F represents a situation of considerable ambiguity. The recommendation was to use NC ("no credit") on internal records, with no report of the registration appearing on external transcripts. But the faculty disagreed. To excise an F from the official record would jeopardize the record's validity, was the argument.

Others of M.I.T.'s many possible grades were continued, with clarifications which the committee hoped would make their use more consistent:

O = For students who were doing passing work but failed to take a required final examination.

OX = A grade of O converted when the Dean for Student Affairs subsequently excuses the absence.

I = Incomplete — for passing students who have not completed "minor" portions of course assignments.

J = A "postponed" signal, to indicate that work — usually a doctoral thesis — is proceeding satisfactorily but not yet finished; credit to this point in the project is assured.

S = An awarding of credit for a subject taken elsewhere.

SA = A satisfactory doctoral thesis.

And a new letter added to the alphabet: T = satisfactory progress in a subject whose duration does not coincide with the term, such as student research and self-paced subjects, the grade to be assigned upon completion.

Adjusting to M.I.T. and Themselves

Perhaps the most acrimonious faculty debate was reserved for the committee's recommendation that the pass/no-credit grading system be continued in all first-year subjects.

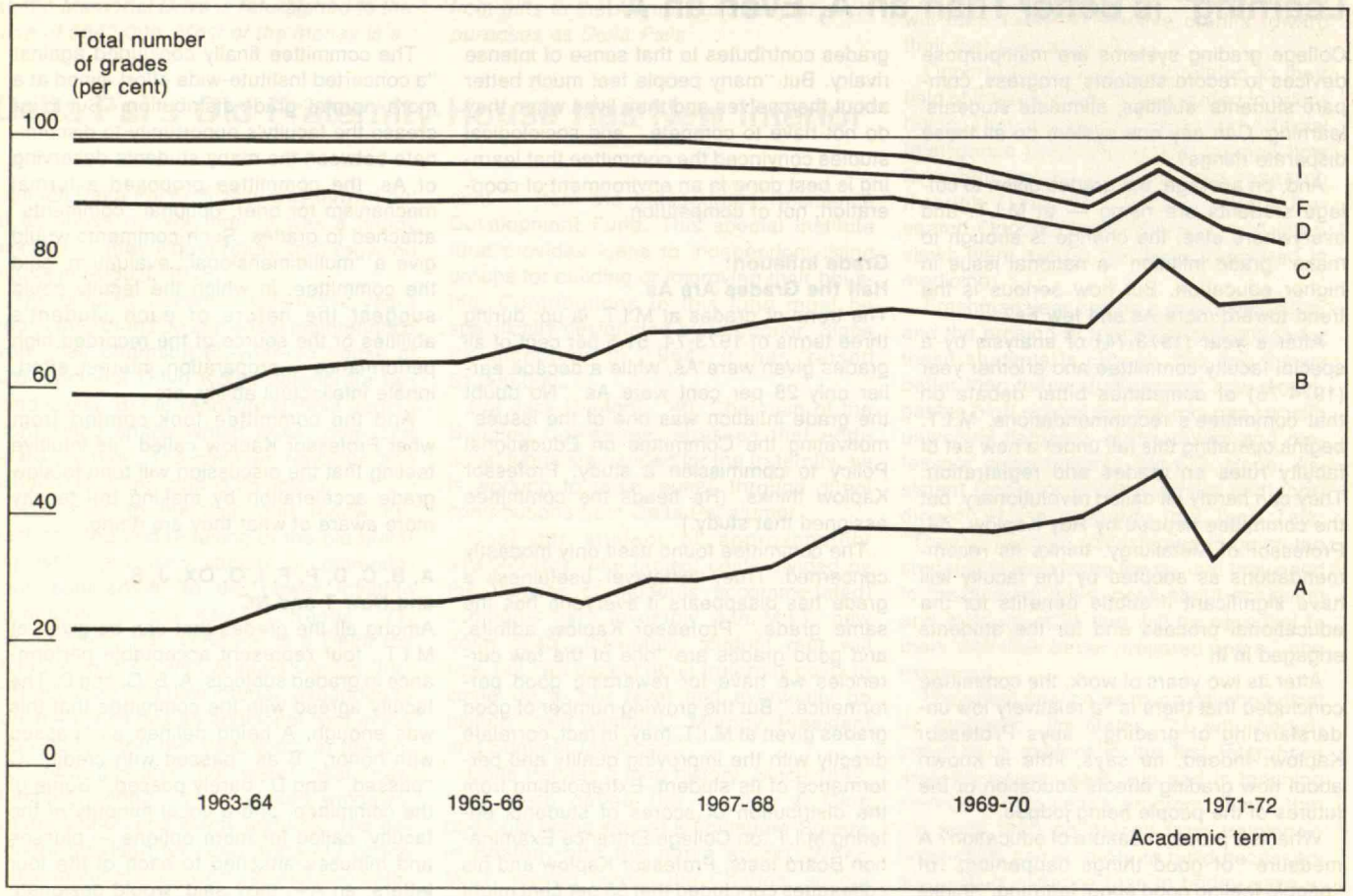
Is the possible reward of a good grade — instead of just a "pass" — an incentive to learning? Or is the competition for high grades destructive of real learning, especially for freshmen who are still uneasy in the M.I.T. environment? Both viewpoints have their faculty advocates; six members of the faculty who proposed that pass/no-credit be limited to the first term of the freshman year wrote that "the pass/no-credit system has tended to compromise academic achievement for a significant portion of the freshman class during not only that year but future upper-class years as well, and delays recognition of students in academic difficulty."

Not so, thought the committee whose view carried the faculty vote. Students are "more relaxed, less competitive, and more capable of in-depth learning"; and students are "more likely to experiment with capability-stretching subjects" under pass/no-credit, the committee argued.

Michael D. McNamee, '76, Editor of *The Tech,* sided with the committee, and most undergraduates clearly agreed: "Each year, many freshmen spend their first term adjusting to M.I.T. and their second term adjusting to themselves, their desires, and their wants," wrote Mr. McNamee. "These freshmen spend their first year here questing, looking around to see what they want to do with their lives, changing majors every other week, developing their personalities and conceptions of themselves. . . . Freshmen . . . use the breathing space given by pass/no-credit to grow and learn."

When Is a Student Really Registered?

The most technical issue in the year-long debate had to do with registration procedures and "drop date" — the last day a student may drop a subject and have no report



"Grade inflation" at M.I.T. is very real — just over 20 per cent of the grades given in the fall term of 1962-63 were As, compared with 45 per cent in 1972-73 (see chart above). But a faculty committee which spent two years reviewing the Institute's grading system is satisfied that M.I.T. students are selected for their superior ability and potential, so "it is hard to find justification for a 'normal' distribution of grades within M.I.T. when the distribution curve of M.I.T. students' abilities does not have a 'normal' shape," said the committee report.

of it on his record. A dilemma: too much flexibility fosters "confusion about the reality of registration," too little risks forcing students into commitments they legitimately cannot fulfill.

A modified procedure recommended by the committee and approved by the faculty: Let registration be finalized by the fifth week of the term; no subjects may be added thereafter. But thereafter, until three weeks before the end of the term, students may drop subjects in which they do not wish to receive credit or grades. Such dropped subjects will appear on internal records but not on external transcripts. — *J.M.*

The Tech Editor Takes An Inside Look at Grading: Making Jokes While Being "Fair and Usually Generous"

How are grades really determined at M.I.T.? Does the faculty simply "spin a little bottle" or roll dice?

In the midst of last year's intense faculty debate on grading, Storm R. Kauffman, '75, then Editor of The Tech, *decided to try to penetrate a process "whose secret is maintained within a small circle of the select." John G. Kassakian, '65, Assistant Professor of Electrical Engineering, and his staff agreed ("courageously," thought Mr. Kauffman) to let the Editor sit in on the final grading session for 6.011, Introductory Network Theory. Mr. Kauffman, impressed, concluded that grading "involves as much discussion and mathematical manipulation as anything at M.I.T." Here are portions of his report, reprinted from* The Tech:

Upon completion of the final examination at noon, the teaching staff of about a dozen were industriously engaged in the grading of the 140 or so exams. The methods used on exams are familiar to most students: each question is farmed out to one of the staff who grades only that question.

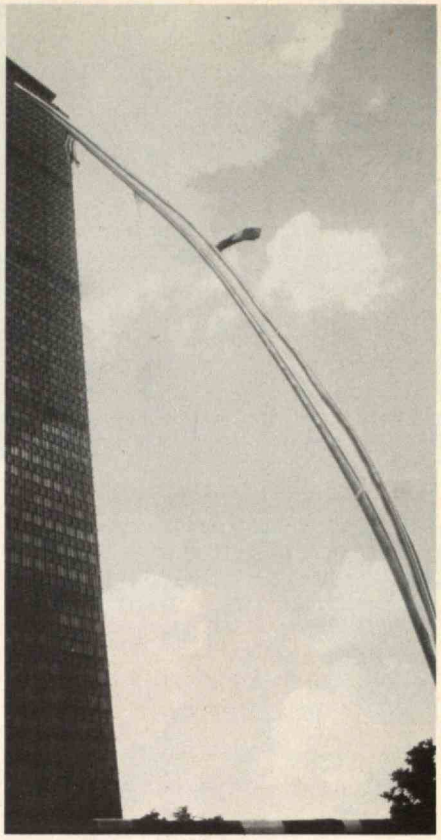
When I arrived, several of the teaching assistants were milling about (eyeing me suspiciously), having just returned from dinner. On the blackboard was a bar graph depicting the results of the final — the usual bell-shaped curve centered somewhere in the 60s with a couple of poor souls in the below-freezing range. The only identified grade was the highest, about 96, the implication being that of course it must be Student X Who Always Did The Best.

Finally, the whole crew arrived and Kassakian called for the computer printouts (electrical engineering subject, remember?) of the tabulated grades of all his students. These contained quiz scores during the term, the final exam grades, the term average, and the term average dropping the lowest quiz grade. Also included are homework grades, which count towards part of the 6.011 final grade. Other printouts included a histogram showing the distribution of the various overall grades.

Professor Kassakian picked a number which represented the 80th percentile, and all students above that grade average would receive an A. The subsequent hour and a half involved the individual recitation instructors arguing for or against their A/B borderline cases. A list of about a dozen was put on the blackboard and discussed by the group, which weighed the importance of not turning in several homework assignments, having an excellent final exam but poor quiz grades, having an atrocious exam but an otherwise good term, demonstrating good knowledge of the subject in class but failing to prove it on quizzes, and other personal judgments. One of the assistant professors was vehement about a student deserving an A although being significantly below the break point.

At the end of this discussion, about half of the students had been kicked upstairs to an A, and it was time to move down to the B/C borderline. Here the process began anew, the various instructors arguing their cases to the group.

What impressed me most about the whole grading session was the intensity of interest displayed by the staff. The recitation instructors all had a good knowledge of their students and were usually able to talk thoroughly about their performance. There was a determination to do the best for the student while not inflating grades to make them meaningless. While the whole process may be somewhat necessarily hurried (it took 13 hours) the staff tried to give serious consideration to all the special or hardship cases. They may make jokes about their students, but they do try to be fair and usually generous. □



A plastic Old Glory, designed by Otto Piene, Director of M.I.T.'s Center for Advanced Visual Studies, floats from the top of Boston's Prudential Tower on July 4 (Photo: William L. Tronzo).

Hooray for the Red White and Blue

M.I.T.'s Center for Advanced Visual Studies brought students and artists from all over the country this summer to participate in a workshop on the history and theory of public celebration. The workshop climaxed, appropriately enough, on July 4 when 23 budding celebrants, lead by Otto Piene, Professor of Architecture and the Center's Director, raised a 730-foot balloon *(above)* — sporting the Stars and Stripes, the Boston 200 logo, and a rainbow flag of Professor Piene's design — to the top of Boston's Prudential Tower.

Three red, white, and blue tubular balloons, secured by a winch on the Prudential's roof, were rolled off a wooden spindle some 700 ft. below. Professor Piene and his band, cheered on by a tense audience assembled in Prudential Plaza, worked over two hours hindered by unpredictable winds of up to 20 m.p.h. In early afternoon the operation was completed and the balloons secure on their unconventional flagpole.

But alas: only a half hour later, one of the balloons ruptured and the celebration came to an untimely halt. Said Professor Piene to a reporter from the *Boston Globe:* "We would have had to haul it down during the night, anyhow." — *D.McG.*

With the Outing Club In the St. Elias Giants

At Haines Junction in the summer, the sun just dips below the horizon at midnight, and by 8 a.m. it's hot. There at Kluane National Park Headquarters in the Yukon Territory of Canada, eight M.I.T. Outing Club climbers assembled last June to begin an 18-day adventure on Mt. Vancouver (15,800 ft.), a major mountain amid the St. Elias giants.

Plans had begun as far back as November, 1974. Bart DeWolf began talking to experienced climbers he knew from the Club; by January their attention was focused on Mt. Vancouver. It was not a well-known area. "We had a crude map, but the most valuable information came from aerial photos taken on a 1935 *National Geographic* expedition by Bradford Washburn, Director of the Museum of Science. They showed the side we wanted to climb."

Tents, cooking equipment, packs, and clothes were purchased and assembled in the spring by the group — Cliff Cantor, '75, Bob Dangel, '71, Paul Ledoux, '66, Rob Milne, '78, Hal Murray, '65, Bob Walker, M.I.T. graduate student, John Yates, and Bart DeWolf, Ph.D. '69, group leader.

Once at Haines Junction on the Alaska Highway, the Outing Club group was checked out by park rangers, bought food ($800 worth), packed, prepared gear, and waited for clear weather for the trip to the base of the northeast ridge of Hubbard Glacier. On June 16, with 500 lbs. of food and 1,000 lbs. of gear, they flew in three helicopter trips to a base camp surrounded by snow and ice at 4,800 ft.

After one day of exploring during the day's heat, they reversed their schedule 12 hours. "We would wake up at 6 p.m., have breakfast, climb some hours in darkness, and go to sleep at dawn." A second camp was established closer to the summit.

But nine days later morale was low. At Camp II, the hardest part of the trip remained ahead — it was a difficult, steep part of the ridge. "We assessed our progress: from base camp at 4,800 ft. to Camp II at 8,200 ft. had taken more than a week. We had originally hoped to make the 15,800-ft. summit in seven to eight days; it took that long to go half way. We had limited time — 18 days was the food limit. It was snowing. And the night schedule never felt quite right," said Dr. DeWolf. There was no clear way to go; the triangular shaped face above was covered with dangerously loose snow and its central gully susceptible to avalanches — several had already fallen where they chose to climb. Trial explorations proved to be dead ends. Swirling fog made the prospect of carrying 60- to 80-lb. packs along such a difficult route depressing. "We were afraid we'd fall off. Food might run out. Bad weather could prevent us from retrieving our stores still at base camp."

Then Paul Ledoux suggested a do-or-die four-day plan: attach ropes to the remainder of the ridge; move everything in one trip ("no one really believed that was possible") to Camp III (at 10,400 ft.) on the fixed ropes; then move to Camp IV, closer to the summit; push for the top.

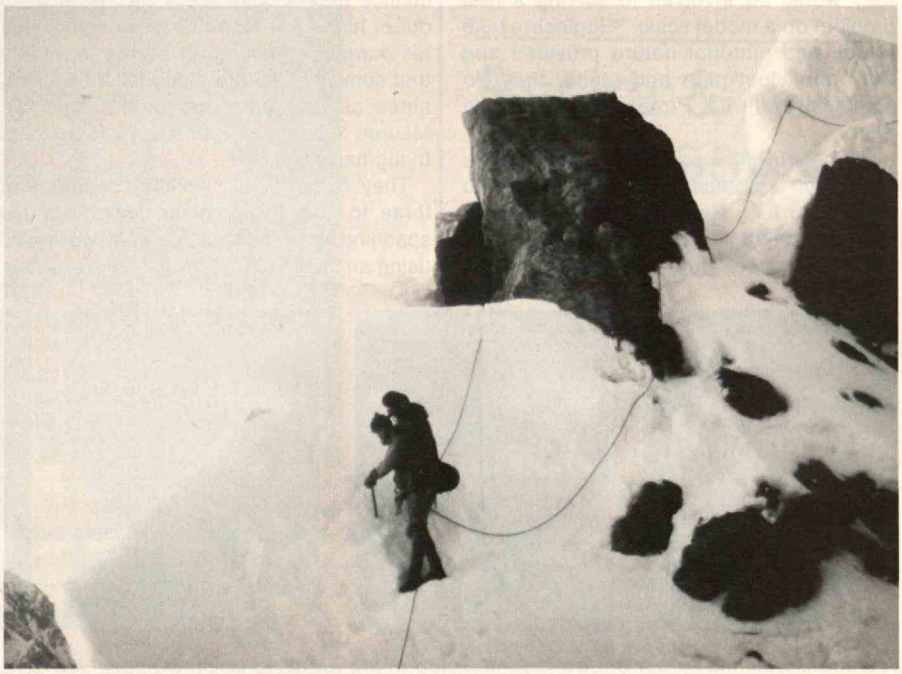
"It was good to focus our efforts on doing rather than searching — it worked even better than we had dared to hope." Sunday morning, June 29, after 12 hours of climbing, the plan to set up Camp IV was aban-

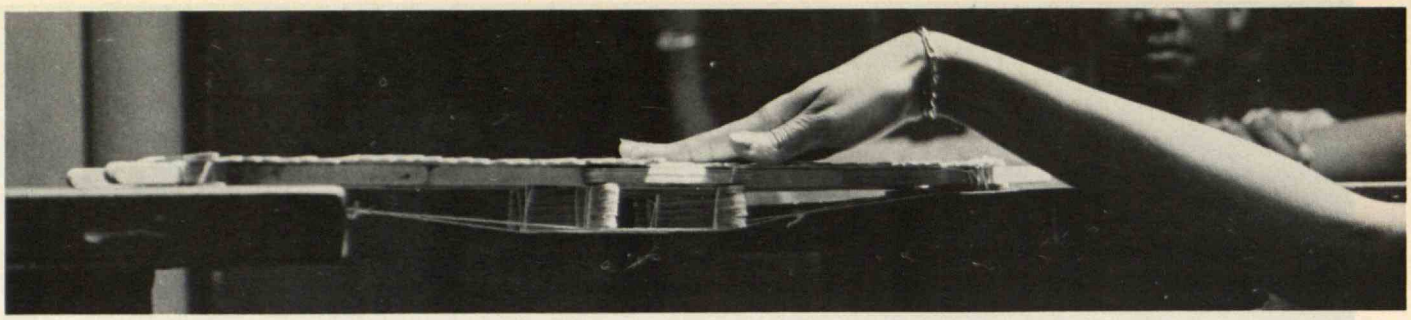
It took Outing Club climbers more than a week to reach Camp II (8,200 ft.), yet the most difficult part of the trip lay ahead: to reach Camp III (10,400 ft.) and a view of Mt. Vancouver's summit (above). Hal Murray, '65, (below) stands at 9,000 ft. To his left – and 5,000 ft. below – is Hubbard Glacier. In the photo at the left: Bob Walker and Hal Murray; the constantly avalanching slope behind them is at least two or three miles away. Opposite page: John Yates, Rob Milne, '78, and Paul Ledoux, '66, on the last half-mile to the summit.

doned; "the unpredictable weather was perfect — low wind, clear, cold — so we decided to push on to the summit."

After returning to base camp, Milne and Dangel left for Haines Junction by helicopter; the rest of the group skied and walked 68 miles over the Hubbard and Kaskawulsh Glaciers to the Alaska Highway in seven days. Bart DeWolf writes in his journal of a moment during this time: "We slept out under the stars in spite of the mosquitos. It was the edge of the wild, with grizzly bears not a hundred yards away. I knew the remaining distance would surely not stop us, and that the next night I would be back in civilization. . .

"The whole scene seemed to say 'Yukon' to me, with its vastness and its uncompromising wildness. I wondered how long it would be able to withstand the onslaughts of visitors and the desire of the new park authorities to provide 'improvements' . . . I hope with all my heart that our experience of it in all its rough splendor will be something that others can enjoy for many years to come." — *M.L.*





M.I.T.E.: Summer School Plus at M.I.T. for Minorities

His computer program begins "Is black beautiful?" and goes from there. If you answer no, it yells at you.

This was one student's project in the computer workshop that was part of a two-week Minority Introduction to Engineering (M.I.T.E.) for high school students sponsored at M.I.T. by the Engineers Council for Professional Development.

The problem is that few members of minority groups go into engineering. To help remedy this, E.C.P.D. set up a plan — now in its second year — to stimulate minority interest in engineering by sending high school students with aptitude in science and math to live on campus at 28 colleges in the U.S. for two weeks.

At M.I.T., M.I.T.E. began on a hot Monday morning in July. Professor Frank E. Perkins, Head of the Department of Civil Engineering who was Chairman of the program, told 38 students about good job opportunities in engineering; that a technical education serves as a good base for other fields, too, in our technical society; that they would hear presentations from the eight departments of M.I.T.'s Engineering School throughout the next two weeks, have computer workshops each day, and go on two field trips. Through a design competition they would be involved in solving a real problem on a model scale. "Engineers take forces and material nature provides and they don't just plan and study, they *do* something with it," Professor Perkins told them.

To begin right away, Professor Perkins suggested a problem to think about: how to enable M.I.T. students to cross Massachusetts Ave. in front of Building 7 more safely. After pondering the intersection during a break, students' suggestions ranged from "increase walk time," to "put a policeman out there," ("no, he'd get killed!"), to "close down M.I.T.," to building elaborate bridges and walkways. In each case, as class discussion began, other problems arose — political, social, economic, aesthetic — and this made it clear that "as an engineer you don't operate in a vacuum. To translate an idea into something that works is a long hard process. A decision must be made after considering all the alternatives — and their ramifications," said Professor Perkins. So engineering education also concerns problems that accompany technical decisions, he told them.

By Wednesday, John Maurer, '75, a fifth-year mechanical engineering student at M.I.T. who was assisting Professor Perkins, was fielding a variety of questions: "What's it like to go to college?" "If you come to M.I.T. do you go to class or do research all the time?" "How many tests; how many hours of class each day?" "I had one student ask if he could just be shown how to log in on the computer and then he would go to lunch," Mr. Maurer said at three o'clock Wednesday afternoon. "That was 11:00 this morning, and he's been there since." Another student was glad to have the chance to see Boston. He had never been out of his native North Carolina — nor had his parents. "Although it seems inevitable that some people are along for a free ride, since all expenses are paid," said Mr. Maurer, "almost everyone is interested and trying hard."

They had a week, working in groups of three, to solve this problem: design a bridge spanning an 18-inch gap between two tables, using an allotment of popsicle sticks, string, glue, thumb tacks and construction paper. It must hold increasing amounts of weight to be suspended underneath. Tools: razor blades to cut string and sticks; bandaids — for you. Failure is said to occur when the bridge breaks or deflects more than 2½ inches. "Dream a little about the solution," said Professor Perkins. "And then *do* it."

The first two bridges held almost 40 pounds; eyebrows were raised. Then Poons, Evans, and Brown came to the front of the room with a straight, flat, glue-coated popsicle stick bridge with no depth — not as pretty as some of the others. It looked like a footpath stretched across the abyss between the tables.

Forty pounds and it held. Fifty. A cheer went up at 64 pounds. An 11-pound weight was gingerly added; the bridge didn't budge. It took 78.9 pounds to cause deflection of more than 2½ inches. The other competing bridges did not surpass this, although they held from 35 to 65 pounds.

"We didn't do research in the library because we didn't think commercial bridges would serve as a good model for a popsicle stick bridge," said Alfred Poons from Boston, of the winning team. "We just talked about it a lot." The other members of his group were Timothy Evans of Chelmsford, Mass., and Chester Brown of Boston.

It was expected, at worst, that some of the bridges wouldn't even hold the support for adding weight. At best, "I didn't think they would hold more than 50 pounds," said a delighted Professor Perkins. Students, too, were surprised. "I thought I was going to look bad and go home hanging my head in shame," said one. But they didn't look bad — they looked great. — *M.L.*

A student watches as her bridge (top) is tested to the breaking point. (Photos: Joe Schuyler)

New Picasso Sculpture, An Island of Delight

Picasso resurrected through technology? At M.I.T. it became possible when a monumental outdoor sculpture by Pablo Picasso was acquired as part of a long-range environmental art program undertaken by the Committee on the Visual Arts.

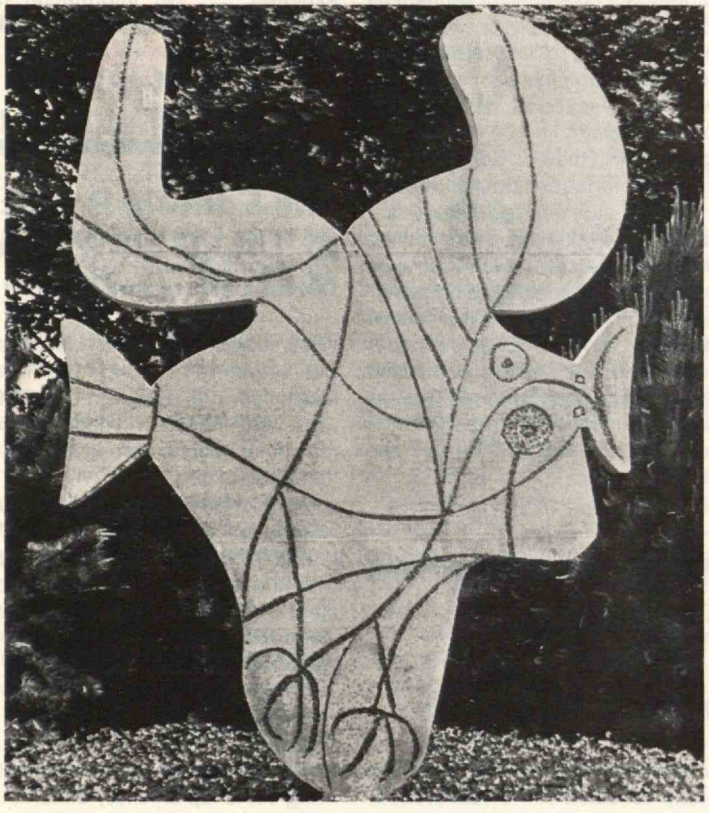
The work, entitled *Figure découpée,* is the first large-scale sculpture by the late artist to be sited in New England. One of a frontal series of oil on wood models conceived by Picasso in 1958, it was executed in large scale from Picasso's maquette by the Norwegian artist Carl Nesjar, a guest artist and former Fellow at the Center for Advanced Visual Studies. Nesjar adapted a unique concrete casting process called *Betograve* for the enlargement of models designed by Picasso.

The collaboration between Picasso and Nesjar began in 1956, and, because of Nesjar's faithfulness to the artist's work, he was given exclusive rights to execute designs approved by Picasso in the *Betograve* technique. A wooden form is filled with an aggregate of stone, and liquid concrete is forced into it under high pressure. When the cast is set, the wooden form is removed, and patterns are carved in the concrete by sandblasting, exposing the aggregate underneath.

The 11-foot figure was permanently installed on May 30 in front of the Hermann Building on the east side of campus. It is one of the last pieces that Picasso authorized to be cast before his death in 1973, and it comes to the Institute through the efforts of President Jerome B. Wiesner who proposed the project which was made possible through the gift of an anonymous friend of M.I.T.

The M.I.T. work exists in two other versions, in Halsingborg, Sweden, and in Amsterdam, the Netherlands. Only three other Picasso sculptures built by Nesjar are located in the United States.

M.I.T.'s Committee on the Visual Arts plans many works on the Institute campus. Other monumental sculptures in M.I.T.'s permanent collection include works by Alexander Calder, Auguste Rodin, Antoine Bowdelle, Theodore Roszak, Jacques Lipchitz, Beverly Pepper, Dimitri Hadzi, Jean Robert Ipousteguy, Mark di Suvero, and Carl Andre. — *S.F.*



Combining the imagery of bird and fish, this sculpture was cast from a model by Pablo Picasso through a unique method called Betograve *by M.I.T. guest artist, Carl Nesjar. It is part of a long-range environmental art program undertaken by the Committee on Visual Arts to address M.I.T. and the Boston community.*

A Master's Degree in Technology and Policy

Are the results of increasingly complex technology and its ever-deeper involvement in human affairs truly beyond our understanding and control?

Not so, said a committee of the M.I.T. faculty last spring. But special training is justified to help engineers work on these issues, and the committee recommended a new interdisciplinary program in Technology and Policy which is being inaugurated at M.I.T. this fall. Some 12 students are expected to enroll for Master's degrees with that designation following approval of the new program by the M.I.T. Corporation on a three-year experimental basis.

"The fact of increasing complexity and breadth of technological problems has, if anything, increased the need for the engineer's special insights and understanding of nature," said the committee report. But his contributions are limited if he does not understand the context of modern technology — economics, systems analysis, and other social sciences.

Students in the program will take a series of subjects to establish their qualifications in one field of engineering — nuclear power, water resources, or computer science, for examples; they will take special sequences in economics, systems analysis, and political science (including a law-related subject); and all will participate in a "project proseminar" for discussion of issues in technology and policy.

After graduation, they'll likely work in government or industry doing "needs analysis, impact studies, technology assessment, project evaluation, and planning and designing large-scale technical systems," says the faculty committee proposal.

Professor Richard L. deNeufville, '60, of the Department of Civil Engineering is Chairman of the faculty steering committee for the new program, and Professor Thomas B. Sheridan, Sc.D. '59, of the Department of Mechanical Engineering will direct the "proseminar." □

Army Intelligence Files at M.I.T.? All Evidence Is Negative

Did M.I.T. computers receive any part of the sensitive data collected in the 1960s under the Army Intelligence Command's Domestic Surveillance Program — and presumably destroyed early in the 1970s?

The Tech published its suspicions late last spring, and during the summer NBC News broadcast more specific reports. Some of the data was alleged to have survived an ordered purge and to have been transmitted over ARPANET. This is an unclassified experimental computer network operated through June of 1975 by the Department of Defense's Advanced Research Projects Agency (A.R.P.A.) to link some 50 universities (including M.I.T.), some government laboratories, and "think tanks" in order to share computer resources for research purposes.

Because such computerized data need never appear on paper, tracing it is difficult. But Louis Menand III, Special Assistant to the Provost, who spent much of the summer investigating the situation, told *The Tech* in August that "everything we have discovered so far is negative.

"Every piece of evidence given to us was checked out," he told *The Tech*, "and we can't demonstrate that the allegations made have any validity."

Dr. Menand has further said that "we can find no reason to believe that any such transmission of Army intelligence files in fact occurred." He thus confirmed a statement of Deputy Assistant Defense Secretary David O. Cooke before the House Subcommittee on Government Information and Individual Rights early in the summer: "Officials at M.I.T. and A.R.P.A. state that no transmission of civil disturbance data over ARPANET was ever authorized, and they have no evidence it ever occurred," he said. "All possible investigative leads, both in Washington and Massachusetts, have been explored. . . . No information has been developed which in any way supports the allegation." □

The Editor's Predictions of Things to Watch at M.I.T. in '75-76

What subjects will make headlines at M.I.T. this year? Three, thinks Michael D. McNamee, '76, Editor-in-Chief of the *The Tech;* and they're so important that debate may in fact persist throughout the tenure of the Class of 1979.

Mr. McNamee's predictions are in his editorial for the summer issue of *The Tech,* in which, he says, the Editor is supposed to have the role of "official greeter" for the new class arriving in the fall. And he cannot resist a plug: "You'll read it all here first," he tells the freshmen.

The three subjects:

— **Money.** Though the Institute "is in no imminent danger of bankruptcy," Mr. McNamee assures the freshmen, "it's not living in the lap of luxury either. . . . a growing gap between operating funds and operating expenses, (so) . . . austerity programs are going to start to squeeze," he thinks. There will be tuition increases and tighter financial aid guidelines, and there will be other "subtle effects": efforts to reduce expenses in Institute Houses, the Medical Department, the Office of the Dean

for Student Affairs — even in academic programs and services such as telecommunications (the M.I.T. switchboard is now closed from midnight to 7:30 a.m.). All this means to Mr. McNamee fewer secretaries, less photocopying, more controls on laboratory supplies, and "general scrutiny for possible savings. Students will feel a pinch," he says.

— **Research "ethics."** Mr. McNamee does not propose that the old issue of defense research will resurface after the violent debates of the 1960s. But now there are new questions: What about involvements with the Central Intelligence Agency? Controversial social science research? Computers and privacy? Does a contract to train nuclear engineers for Iran contribute to spreading the peril of nuclear war? In general, for whom and under what terms should M.I.T. contract to teach, perform research, and consult?

— **Activism.** How will students respond to these issues? Mr. McNamee recalls "a lot of name-calling between administrators and students" last year over the threat of compulsory "commons" in Houses and training programs for Iranian nuclear engineers. Will there be protests, even riots? Probably not, but "idealism, apathy, and activism . . . will bear watching this year." □

Equal Sports: No Need for Title IX

The controversial federal guidelines insuring equal access to athletics for men and women were not controversial at all at M.I.T., says Professor Mary Lou Sayles, Director of Women's Athletics. The whole thing, she says, was "anticlimactic," because "M.I.T. has been committed right along to the same quality of opportunity for men and women."

But there are still a few frustrations.

Professor Sayles wishes the Title IX guidelines had included the requirement for equal spending on men and women of college athletic funds. The problem is especially difficult in a time of budget stringency: M.I.T., for example, has cut an equal percentage of games from the men's and women's basketball schedules for 1976; but the two schedules were different last year, and so, Professor Sayles says, the women "will suffer more lost play time" this coming season.

M.I.T.'s policy is to provide coaching for women as soon as a group of coeds "prove themselves worthy of good coaching." To Professor Sayles that seems a bit self-defeating: Without good coaching, how can a team prove itself worthy of it? "Athletes perform and win only because good, sound coaching is already established," she says.

Professor Sayles accepts — at least for the present — the "equal but separate" concept for men's and women's sports. Physiological differences still separate men and women on the athletic field — men are simply stronger and faster, on average. Can the new regulations change that? They just might, thinks Professor Sayles. If women have "equal opportunity, equal attention, and equal encouragement from the first grade on," they may in time overcome their physiological handicaps. □

"Strategic Arithmetic": A Lesson in How to Multiply Without a Multiplication Table

Alan Natapoff, a physicist who is Research Associate in the M.I.T. Man-Vehicle Laboratory, counts on his fingers.

He has taught children with learning disabilities to count on theirs; and those children, sometimes after years of frustrating failure, have thereafter become able to add, multiply, and divide without using their fingers — to learn what they had grown to believe they could not learn.

In his assignment for the Man-Vehicle Laboratory, Dr. Natapoff is in the business of discovering how the brain works, not of using a new system to teach children how to do arithmetic. But the by-products of research often prove valuable in unexpected ways; hence his development of what he calls "strategic arithmetic."

The basic question Dr. Natapoff is seeking to answer for the Man-Vehicle Laboratory is what happens when the brain meets a new abstraction. Helping students learn to add five plus five fits into this picture because "a child trying to learn arithmetic is a perfect setting in which to study the reaction of the brain to a new abstraction," says Dr. Natapoff, whose Pied-Piper-like ability to attract and hold the attention of students has won the admiration of teachers everywhere.

"Consider the paradox presented by the teaching of arithmetic," he said. "Multiplication and long division are abstractly very closely related. Therefore, they should be similar in difficulty. But they are not.

Dr. Natapoff's method, which he says can be used to teach multiplication and long division three to ten times as fast as the usual method, is the same whether he is teaching "normal" children or children with learning problems. The only difference, he says, is that one teaches more slowly and shifts the emphasis when teaching children with memory problems.

A "Math Magician" at Work

At the Hennigan School in Boston's Roxbury section four children were learning how to multiply. They sat side by side, barely three feet from the blackboard where Dr.

Natapoff had chalked the problem. There were several teachers from school systems in Weston, Cambridge, and Watertown in the room as well as a *Boston Globe* reporter and a photographer-writer team from the M.I.T. News Office.

Some of the people arrived after Dr. Natapoff had begun the session and some left while it was in progress, but the attention of the four children never wavered.

A few of the Hennigan School's teachers stood next to the children, observing how they reacted to his instructions and occasionally helping a student understand some part of the process.

Dr. Natapoff used the child's first name nearly every time he spoke to a student and frequently used emphatic expressions of praise to reward the correct answer.

Reporter Phyllis Coons of the *Boston Globe*, who referred to Dr. Natapoff as a "math magician" in her later article, described what was happening this way:

Multiplying 12 by 7,632

Four youngsters in grades 6-8 who had been doing second grade work in arithmetic were multiplying into the millions. Yet they were acting as if the multiplication table had not been discovered. Instead of multiplying, they added various numbers of dozens and added zeros to magnify by ten.

Dr. Natapoff was giving them their third lesson. One boy had missed the second, but he was catching up with the others fast.

First they made a table listing the sum of 12, two 12s, four, eight and 16 dozens. "Think of the number 12 as a dozen eggs," said Dr. Natapoff.

Next they learned to multiply 12 by 7,632. Breaking down the first number, seven, into units of 12 by copying the table they got:

4	12s =	48
2	12s =	24
1	12 =	12
7	12s =	84

The next step was to multiply that seven by ten by adding a zero and another zero to the 84, the sum of seven 12s.

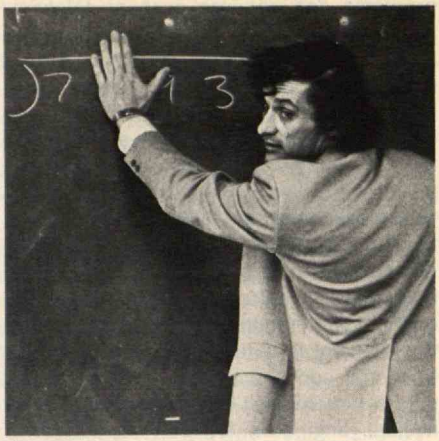
Returning to the blackboard, Dr. Natapoff pointed to the second digit in the figure 7,632 — six. Under the 70, he copied two numbers from the chart adding up to six:

70		840
4	12s =	48
2	12s =	24
76		912

Then Dr. Natapoff repeated the process of multiplying each sum by ten to get 760 and 9,120 and adding the next number three.

2	12s =	24
1	12 =	12
763		9156

The final step was to multiply by ten and add the last digit, two.



From Dr. Alan Natapoff's interest in understanding how the human mind tackles abstraction – part of his work as Research Associate in the Man-Vehicle Laboratory – has come a concept he calls "strategic arithmetic." The idea is to reduce multiplication to addition, and the result is simple enough so that even children with serious learning disabilities can tackle problems as tough as multiplying 7,632 by 12.

7630		91560
1	12 =	12
1	12 =	12
7632		91584

or 7,632 times 12 is 91,584.

"Sure it takes longer to add instead of multiply, but we can afford to take longer to compute. We can't afford to take a year or more to teach multiplication and still see kids fail to learn how," Dr. Natapoff said.

Long division works in a reverse process, by subtracting different numbers of dozens.

In a matter of 22 lessons, Natapoff can teach children with learning disabilities both multiplication and long division.

"This method is a way of decoding a problem into smaller pieces," said Dr. Natapoff. Instead of teaching an abstract idea in an abstract language and thereby trying to teach two new things at once, he uses a formula which avoids learning the multiplication table by rote. □

Affirming Affirmative Action for Women

Concerned that layoffs occasioned by budget cutting for 1975-76 might fall most heavily on women and minorities whose numbers have increased sharply at M.I.T. since 1970, Mary Rowe, Assistant to the President for Women and Work, asked for reassurance from President Jerome B. Wiesner, Chancellor Paul E. Gray, '54, and

John Wynne, Vice President for Administration and Personnel. The answer was unequivocal: the Institute will "brook no setting aside of affirmative action," Dr. Rowe told the Women's Forum this spring.

Despite her title, Mary Rowe does not view her role as primarily a "women's advocate" — she makes her business the civil rights of all members of the community. Hence the breadth of her progress report to the Women's Forum.

The most significant advances in minority hiring have been made in the biweekly (secretarial and clerical) category — 12 per cent of whom are from minority groups. Of the 482 staff members (not including faculty), 30 per cent are women, an increase of 22 per cent since Dr. Rowe came to M.I.T. in early 1973; 9 per cent are minority women. Gross pay gaps are still due to different average ages of men and women in the same job classifications, but these gaps have narrowed. And unlike biweekly employees, Dr. Rowe stated, staff members are on the average paid competitively with similar jobs in profit-making institutions in the Boston area.

There has been a tripling of women faculty since 1970. But Dr. Rowe countered this impressive fact — adding that we have only 58 women out of nearly 1000 — not nearly meeting M.I.T.'s goals. She also expressed alarm at the drop in the rate of applications of women students: 14 to 15 per cent, down from 20 to 21 per cent.

Contrary to the myth that black women benefit most by the combined advocacy of black, women's, and union movements, they are still in the worst position at M.I.T., said Mary Rowe. In addition to recruiting more minority women, she urges improved communications and grievance procedures.

Dr. Rowe thinks that M.I.T. has achieved some significant improvements for its biweekly employees in the past year. Advancements she cited were: their further inclusion into the pension and tax-deferred annuity plans, more extensive tuition assistance, an extended health plan including breast examinations and more counseling services, and a better parental leave policy.

A "signal change" has been made in career devlopment for nonstaff employees. The new system of posting Institute job opportunities has aided job transfers. But also, Mary Rowe thinks the attitudes of administrators are changing. She foresees in the next few years more acceptance of the idea "that secretaries, like graduate students, expect and have the right" to job advancement.

Under consideration are programs which would allow greater job flexibility. There is a need "for mechanisms by which employees can have more control, on a planned and voluntary basis, over their work situations," Dr. Rowe stated. Possibilities include changes in leave polisy, and what she called an "undertime job" by which an employee might take a modest (two to six per cent) salary cut in order to be released for five to 15 work days during a year.

No one member of the M.I.T. administration can assure progress for women at M.I.T., says Dr. Rowe. "An enormous strengthening of women's groups is necessary," she said, to achieve the more long-lasting effect of "grassroots rather than token representation." In this respect there have been "salient achievements by some 25 groups of women here who meet together regularly. Across the country," she said, alluding to the nationwide efforts to unionize clerical and secretarial employees, "women are organizing in unions." Regardless of one's opinion of clerical unions, one must view with respect the fact that women are striking out in a different direction with a form of organization that has traditionally been predominantly male, she said.

Mary Rowe gives visibility to the M.I.T. concern for women; her office is a focus for information and assistance. But more important is her personal involvement, unexpected in a place as large as M.I.T.: relaxed and genuine to the large numbers of women who talk with her daily, Mary Rowe is more than someone "who looks like them." — *S.F.*

M.I.T.'s National Crew Champions Are Stopped at the Henley Semi-Finals; London Was Too Much for Us

"We have no excuses," says Coach Peter Holland. It's just that they were better than we were.

At the Henley Royal Regatta at Henley-on-Thames, England, the junior varsity fell before the University of London varsity in the semi-finals. It was their third defeat since winning the Kennedy Challenge Cup of the Intercollegiate Rowing Association in Syracuse in June *(see July/August, p. 75)*. But no hard feelings: it was a good race, "our very best," Mr. Holland said. And the outcome could hardly have been unexpected: already the University of London crew had beaten the junior varsity rowers twice in the Nottinghamshire International Regatta a week before the Henley.

An M.I.T. four-man crew won the Elite Four title at Nottingham on June 28; but they drew the Vesper Boat Club, America's best four, in the opening round at Henley on July 3 and lost by a length after leading for half the race.

"Both our crews rowed very well," Coach Holland told *Tech Talk* upon returning from England in mid-July. "In the races they lost, both boats rowed better than ever before." □

People

Frank E. Perkins

N. C. Rasmussen

A New Professorship To Honor Soderberg

Grants to the M.I.T. Leadership Campaign from United Technologies Corp. (formerly United Aircraft Corp.) of Hartford, Conn., and ASEA-Stel-Laval of Sweden have provided initial funding for the Carl Richard Soderberg Professorship in Power Engineering.

Dr. Soderberg graduated from M.I.T. in 1920, and during 22 years' service on the M.I.T. faculty — from 1938 until his retirement in 1960 — established himself as a prime mover in engineering education. The two grants honor him for long service to the companies involved as inventor and consultant, as well as for his contributions through engineering education at M.I.T.

The Professorship itself honors "one of M.I.T.'s most illustrious teachers who also gained international recognition for his pioneering work in the design and development of turbine engines," in the words of Paul E. Gray, '54, Chancellor.

The Soderberg Professorship will be given to promising young members of the M.I.T. faculty "to enhance their career development in teaching and research," said Dr. Gray.

Dr. Soderberg was Professor of Applied Mechanics from 1938 to 1942, Professor of Mechanical Engineering from 1942 to 1959, Head of the Department of Mechanical Engineering from 1947 to 1954, and Dean of the School of Engineering from 1954 to 1959; he was named Institute Professor — the highest academic rank at the Institute — in 1959. Many of his academic colleagues credit Professor Soderberg with building and leading "one of the world's leading mechanical engineering departments," said Dr. Gray.

Dr. Soderberg is a native of Sweden, and he has maintained close associations with that nation and its industry throughout his career. □

"The Real Source of Joy in Teaching . . ."

Why a Professorship in honor of Carl Richard Soderberg?

The answer is made clear in extracts from a personal communication from Professor Soderberg to one of his colleagues and former students which the *Review* is privileged to share with its readers:

"The real source of joy in participating in creative work and teaching is to see groups of young, gifted, and earnest people catch the spark and continue farther than I ever myself dreamt to be possible. . . . I have been singularly fortunate in these associations, mostly as a participant, occasionally pretending to be a leader, . . . all dealing with the theme of making the process of technology meaningful and effective, as well as to have a soul.

"If doubts have arisen about the ultimate effect on our society, even those doubts become part of the process.

"Whatever man's fate may be, he will always remain dependent on effective utilization of youthful spirits with their ideals intact. The difference [between the past and] the future is . . . that such efforts must now be made meaningful even in an atmosphere of doubts and anguish."

Perkins, Rasmussen, Solomon, New Heads

Three major academic units at M.I.T. are under new management, effective July 1:

— **Frank E. Perkins,** '55, Professor of Civil Engineering — as Special Assistant to the Dean of Engineering since 1973 he has become an expert on the balance between engineering science, technologies, and systems in U.S. engineering education — is Acting Head of the Department of Civil Engineering.

— **Norman C. Rasmussen,** Ph.D.'56, Professor of Nuclear Engineering — he directed a massive study of nuclear reactor safety for the U.S. Atomic Energy Commission in 1972-74 — is Head of the Department of Nuclear Engineering.

— **Arthur P. Solomon,** Associate Professor of Urban Studies — his specialty is housing and community development — is Director of the Joint Center for Urban Studies of M.I.T. and Harvard.

Professor Perkins succeeds Professor Peter S. Eagleson, Sc.D. '56, who will return to full-time teaching in his field of hydrology and coastal processes; he has been Head of the Department since 1970 and has notably expanded the scope of its teaching in the systems and environmental factors affecting engineering.

Professor Perkins has been at M.I.T. since 1951, when he arrived with the Class of 1955. As a graduate student he was awarded the Goodwin Medal for effective teaching while earning S.M. (1959) and Sc.D. (1966) degrees; and he was Associate Head of the Department's Water Resources Division before 1973.

Professor Rasmussen is by any standard one of the country's outstanding nuclear reactor engineers; "his academic work, his research, and his recent activities in connection with the safety and environmental impact of nuclear power are unsurpassed," says Alfred A. H. Keil, Dean of the School of Engineering.

Professor Rasmussen came to M.I.T. for graduate study in physics in 1950, the year he finished his bachelor's degree at Gettys-

Arthur P. Solomon

Weston J. Burner

W. Thad Byrd

Alan F. White

Thomas F. Jones

Norman Doelling

burg College; six years later he became an instructor in physics, and in 1958 he joined the Department of Nuclear Engineering as Assistant Professor.

Professor Edward A. Mason, Sc.D.'50, the second Head of M.I.T.'s Department of Nuclear Engineering, took a leave of absence in January, 1975, when he was appointed to the Nuclear Regulatory Commission, and Kent F. Hansen, '53, Professor of Nuclear Engineering, was Acting Head from January to July; now he will return to teaching on a full-time basis.

Professor Solomon studied at Brown University (A.B. 1961); served as Director of Manpower and Economic Development at the United Planning Organization, Washington, D.C., and a member of President Lyndon B. Johnson's White House Task Force on Government Organization; then returned to Trinity College for a Master's degree (1968) and Harvard for his doctorate (Ph.D. 1971); and since 1971 has been Associate Director of the Joint Center as a member of the M.I.T. faculty. He has written extensively on urban reconstruction, housing finance, poverty and inequality, and strategies for urban growth.

Under the direction of Professor Bernard J. Frieden, Ph.D.'62, the Center has focused its work on critical issues of public policy in relation to urban affairs. That emphasis will continue, says Professor Solomon. Meanwhile, Professor Frieden will return to teaching in the Department at M.I.T. and will continue research at the Joint Center. □

Administrators Named

Four major administrative appointments were announced during the summer:

— **Weston J. Burner,** Director of the Information Processing Center, will now assume the additional job of Director of the Office of Administrative Information Systems. The practical result will be combining, under Mr. Burner's direction, the information processing work dedicated to teaching and research and that devoted to administration; Robert H. Scott, Director of Information Processing Services, hopes that the consolidation will save money and provide more powerful and diverse services for both classes of users.

Mr. Burner came to M.I.T. in 1969 after a career in business systems and information processing with General Electric Co.

— **W. Thad Byrd,** '74, formerly an intern in the M.I.T. Admissions Office, is Assistant to the Director of the M.I.T. Educational Council; he will be in charge of the Council's office while William J. Hecht, '61, Director, is on a year's leave of absence attending the Sloan School of Management under an Alfred P. Sloan Fellowship.

As an undergraduate in humanities (his fields of concentration were music and electrical engineering), Mr. Byrd worked in the Student Financial Aid Office, and he was an active member of Delta Tau Delta fraternity.

— **Norman Doelling,** '53, is now Manager of the Marine Industry Advisory Service of the M.I.T. Sea Grant Program. His job will be to link research and teaching at M.I.T. to marine-oriented industries whose needs M.I.T. may be able to fulfill, and to publicize findings from M.I.T. which may be useful to industry.

Mr. Doelling has recently been self-employed, serving high-technology companies seeking opportunities in Japan. Earlier he was associated in underwater physics and oceanography with Bolt, Beranek and Newman and in computer services with General Electric Co. and Digital Equipment Corp.

— **Alan F. White,** S.M. '71, since 1973 Associate Director for Executive Development Programs in the Sloan School, has been named Director. He will be responsible for the School's Program for Senior Executives and its Urban Executives Program, and he will teach in the School's Master's program.

Mr. White was associated with the University of Hawaii before coming to M.I.T.; he attended the Sloan Fellowship Program in 1970-71 while on that University's administrative staff. □

Thomas F. Jones Is Vice President-Research

Thomas F. Jones, Sc.D. '52, came to M.I.T. for graduate study in electrical engineering in 1938 from Mississippi State College — a cheerful, round-faced, red-haired southerner (from Tennessee). He returned after World War II service to become a member of the faculty (1947) and to continue graduate work leading to the Sc.D. degree in the field of computers and instrumentation.

Now Dr. Jones, who has in the meantime been Head of the School of Electrical Engineering at Purdue University (1958 to 1962) and President of the University of South Carolina (1962 to 1974), has joined the senior administration of M.I.T. as Vice President for Research. He succeeds Albert G. Hill, a distinguished electrical engineer, who retired from the vice presidency on June 30.

Since giving up the presidency of the University of South Carolina, Dr. Jones has held the title of Distinguished Professor at that university; and last year Dr. Jones — at M.I.T. — was Visiting Professor associated with the Division for Study and Research in Education and the Center for Advanced Engineering Education. As Vice President, Dr. Jones will continue to hold his professorial titles at South Carolina and in the D.S.R.E. and Department of Electrical Engineering and Computer Science at M.I.T.

Dr. Jones is Vice President-Education of the Institute of Electrical and Electronic Engineers, of which he is a Fellow; and he has been President of the Southern Association of Land Grant Colleges and State Universities (1969-1970) and a member of the National Science Board (1966-72). As Vice President for Research, Dr. Jones will be the chief administration official responsible for sponsored research throughout the Institute and for Lincoln Laboratory. □

Individuals Noteworthy

Kudos: Honors, Awards, Citations

Three students in the M.I.T. Department of Aeronautics and Astronautics won prizes at the Northeast Regional Student Conference of the American Institute of Aeronautics and Astronautics. To **Val M. Heinz,** '75, first prize of $150 in the undergraduate written/oral division; to **William Kosmann,** '77, $75 first prize in the undergraduate oral division; and to **Ed Bergmann,** graduate student, $50 third prize in the graduate written/oral division . . . **Louis F. Coffin,** Sc.D. '49, was awarded the Charles B. Dudley Medal of the American Society for Testing and Materials . . . to **James V. Eppes,** M.E. '50, the Lehigh (Pa.) Home Club's 1975 Distinguished Service Award.

John G. Lee, '21, was named one of the first honorary members of the University of Hartford's Board of Regents . . . **Frank S. Wyle,** '41, was named honorary fellow of the Institute of Environmental Sciences . . . **Bernard T. Feld,** Professor of Physics at M.I.T., won the American Institute of Physics' Leon Szilard Award . . . and **Joseph K. Dillard,** S.M. '50, was elected to the National Academy of Engineering.

To **P. Gene Smith,** S.M. '48, an honorary degree in electrical engineering from the University of Missouri at Rolla . . . **Julie A. Moir,** graduate student in the M.I.T. Department of Urban Studies and Planning, will spend a year in Asia as one of 15 participants in the Henry Luce Foundation's Luce Scholars Program . . . **Kenneth N. Stevens,** '52, Professor of Electrical and Bioengineering at M.I.T., was elected president-elect of the Acoustical Society of America . . . to **David J. Rose,** Ph.D. '50, Professor of Nuclear Engineering at M.I.T., the 1975 Arthur Holly Compton Award . . . to **Arthur B. Metzner,** Sc.D. '51, an honorary doctorate from the Catholic University of Leuven in Belgium . . . to **Ivan A. Getting,** '33, the 1975 Pioneer Award of the Aerospace and Electronics Systems Society, Institute of Electrical and Electronics Engineers, Inc.

Honorary degrees went to seven members of the M.I.T. faculty and staff this year: **John M. Buchanan,** John and Dorothy Wilson Professor of Biochemistry, from De Pauw University . . . **James T. King,** Project Officer in the Resource Development Office, from Massachusetts College of Pharmacy, . . . **Benjamin Lax,** Ph.D. '49, Professor of Physics and Director, Francis Bitter National Magnet Lab., from Yeshiva University . . . **Walle J. H. Nauta,** Institute Professor and Professor of Neuroanatomy, from the University of Rochester . . . **Mary Rowe,** Special Assistant to the President and Chancellor for Women and Work, from Regis College . . . **John B. Stanbury,** Professor of Experimental Medicine, from the University of Leiden, Holland . . . and **Hans-Lukas Teuber,** Professor of Psychology and Head of the Department of Psychology, from the University of Geneva, Switzerland.

Stephen Lawrence Hauser, '71, was granted the M.D. degree, magna cum laude, by Harvard School of Medicine . . . **William T. Morris,** '50, won the American Institute of Industrial Engineer's Fellow Award . . . to **Robert P. Gelardin,** '66, of Gelardin/Bruner/Cott, Inc., a 1975 Boston Society of Architects Housing and Neighborhood Design Award . . . to **Miles N. Clair,** S.M. '23, honorary membership in the American Concrete Institute . . . to **Arch C. Luther,** '50, a 1975 David Sarnoff Outstanding Achievement Award; and a similar team award to **George H. Stevens,** '51 . . . to **Thomas W. Lambe,** '44, Edmund K. Turner Professor of Civil Engineering at M.I.T., the American Society of Civil Engineers' Karl Terzaghi Award . . . to **Michael L. Dertouzos,** Ph.D. '64, Professor of Electrical Engineering and Director of Project MAC at M.I.T., the 1975 Frederick Emmons Terman, Sc.D. '24, Award of the American Society of Engineering Education's Electrical Engineering Division.

To **E. Alfred Picardi,** '47, a $7500 award from the Lincoln Arc Welding Foundation . . . to **Jay K. Lucker,** Director of the M.I.T. Libraries, the Distinguished Service Award of the College and University Section of the New Jersey Library Association . . . to **Douglas T. Ross,** S.M. '54, the Numerical Control Society's Joseph Marie Jacquard Memorial Award . . . to **Benjamin Epstein,** '38, the 1974 Shewhart Medal by the American Society for Quality Control . . . to **Michele Rhona Flicker,** Ph.D. '73, Clarkson College of Technology's 1975 Le Mer Award . . . to **Paul L. Hooper, Jr.,** '72, silver wings from the U.S. Air Force following his graduation with honors from pilot training.

Perhaps most noteworthy of all — or at least most esoteric — is the North American Tiddlywinks Pairs Championship claimed by **David H. Lockwood,** '75, following tough competition with nearly two dozen top tiddlywink contestants at the M.I.T. Student Center.

Counselors: Officers, Directors, and Advisors

Albert J. Kelley, '48, Dean of the School of Management of Boston College, has been elected a member of the Draper Laboratory Corp. . . . **Ralph Landau,** Sc.D. '41, to Chairman and Chief Executive Officer of Halcon International, Inc., a company which specializes in organic chemicals and catalysts . . . **H. King Cummings,** '39, reelected to a second term on the Board of Trustees of Colby College . . . **Ronald C. Wornick,** S.M. '60, to the Board of Directors of the Clorox Company . . . **Bernard Friedman,** Ph.D. '71, Assistant Professor of Economics at Brown University, to the advisory council of the National Institute of Allergy and Infectious Diseases.

Philip M. Morse, Professor Emeritus of Physics at M.I.T., to Chairman of the governing board of the American Institute of Physics . . . **Charles H. Smith, Jr.,** '42, immediate past Board Chairman of the Chamber of Commerce of the United States, to Chairman of the Chamber's Executive Committee . . . **John Blair,** '54, to Consulting Scientist at Raytheon Co., the highest professional scientific and engineering level obtainable at Raytheon . . . **David L. Rosenbloom,** Ph.D. '70, Director of the Parkman Center for Urban Affairs, to Boston Mayor Kevin White's Executive Assistant . . . **George P. Shultz,** Ph.D. '49, President, Bechtel Corp. and a former Secretary of the Treasury of the United States, to the Board of Trustees of the Alfred P. Sloan Foundation.

William J. Byrne, S.M. '70, named by Massachusetts Governor Michael Dukakis the Commissioner of the Massachusetts Development Commission . . . **S. William Gouse, Jr.,** Sc.D. '58, to Deputy Assistant Administrator for Fossil Energy of the Energy Research and Development Administration . . . **John William Poduska,** Sc.D. '62, to the Board of Directors of Prime Computer Inc.

Items of Interest

Robert W. Green, S.M. '58, and **Arnold F. Stancell,** Sc.D. '62, were chosen to participate in the Black Executive Exchange Program's lecture series in Applied Engineering at South Carolina State College . . . **Tom Fitzgibbon,** E.E. '60, **Dave Swanson,** S.M. '53 and **Mike Blitch,** S.M. '69, ran in the Patriot's Day Boston Marathon last April . . . John Wiley and Sons, Inc. has published a new book by **Leonard Kleinrock,** Ph.D. '63: *Queueing Systems, Volume One: Theory* . . . **Albert R. Gurney, Jr.,** M.I.T. Professor of Literature, opened the season for London's Basement Theatre with his play, "The Rape of Bunny Stuntz" . . . **Malcolm S. Stevens,** '34, retired June 30 as Vice President for Administration at Brown University.

Appointments: Rising in the World of Business

Stephen J. Lukasik, Ph.D. '56, Vice President for the technical staff of Xerox Corporation's information technology group . . . **Thomas C. Munnell,** S.M. '64, Vice President, Administration of Wm. Underwood Co. . . . **Ralph R. Ragan,** S.M. '52, Vice President of Publications for the American Institute of Aeronautics and Astronautics . . . **Stanley I. Skelskie,** '44, Vice President of Herbert V. Shuster, Inc. . . . **Allan Elston,** '51, Senior Vice President, Consolidated Foods Corp. . . . **Richard E. Cole,** S.M. '52, President of Canadian Reynolds Metals Co. . . . **W. H. Krome George,** '40, Chairman of the Aluminum Company of America . . . **Kenneth N. Stevens,** Sc.D. '52, President-elect of the

Acoustical Society of America . . . **Chong-Jin Lee,** Sc.D. '65, Staff Vice President, Planning, A.M.F., Inc. . . . **Nelson E. Stefany,** '61, President of the health services subsidiary of Rohm and Haas Co., Consolidated Biomedical Laboratories.

Alan R. Gruber, '46, Vice President, Corporate Development of International Basic Economy Corp. . . . **Rocco A. Petrone,** M.E. '32 . . . President and Chief Executive Officer of the National Center for Resource Recovery, Inc. . . . **Douglas T. Ross,** S.M. '54, Chairman of the Board of Directors of SofTech Co. . . . **Cornelius Peterson,** '58, President of SofTech Co. . . . **Bruce C. Murray,** '53, Director of Jet Propulsion Laboratory . . . **Charles C. Noble,** S.M. '48, Vice President of the Corporation of Chas. T. Main, Inc. . . . **Philip J. Robinson,** '61, Vice President-International Operations of Industrial Nucleonics Corp. . . . **Stanley K. Plotnick,** S.M. '64, President of Superior Electronics Industries Ltd.

Career Changes

Kenneth E. Hickman, '57, Vice President of Engineering of the O.E.M. Product Group at the York division of Borg-Warner Corp. . . . **Anthony Stathoplos,** '51, Director of Nuclear Safety of Combustion Engineering, Inc. . . . **Manfred E. Becker,** '51, Director of Product Engineering of the Fafnir Bearing Co., a division of Textron . . . **William D. Chandler,** '55, Plant Manager for Potlatch Corporation's new bleached pulp and paperboard mill . . . **Arthur W. Busch,** S.M. '52, Vice President for Environmental Affairs of the Southwest Research Institute.

Frank Finney, '43, Managing Editor of the *Oakland Tribune* . . . **James F. Mallay,** S.M. '61, Manager of Liquid Metal Fast Breeder Reactor Components of Babcock and Wilcox Co. . . . **Maxine Savitz,** Ph.D. '61, Director of the Division of Buildings and Industry of the Energy Research and Development Administration . . . **Charles A. Huebner,** S.M. '60, Manager of Group Strategic Planning and Review Operation for General Electric's Special Systems and Products Group . . . **Ludwig Chang,** '74, Business Manager for Doubleday Advertising Co., Inc.

Donald S. Macdonald, '38, Associate Professor of Political Science at East Stroudsburg State College, has been given extended leave to serve as Senior Civilian Advisor to American military forces in Korea . . . **Charles M. Saffer,** '36, to Technical Director of the new Inorganic Specialities Division of Witco Chemical Corp. . . . **William H. Heiser,** Ph.D. '62, to new Chief Scientist of Air Force Systems Command's Arnold Engineering Development Center, Tenn.

Samuel J. Davy, S.M., '58, former President of Intronics, Inc., has joined the professional staff of Arthur D. Little, Inc. . . . **Lucille Roseman,** 'S.M. '72, to Treasurer and Chief Financial Officer of Xenergy, Inc., of Concord, Mass. . . . **Edward P. Brandeau,** '47, to Manager of New Business Development of Brand-Rex Co. . . . **Frank Leitz,** '55, to the Department of Reclamation in Denver, Colo. . . . Three M.I.T. alumni to become Associates at the engineering consulting firm of Simpson Gumpertz and Heger, Inc.: **Logan Donnel,** '66; **Raymond W. LaTona,** '70 Ph.D.; and **John W. Nevins,** '51.

Appointments: Moving Up in Academe

Felipe Prestamo, M.C.P. '65, has been appointed Acting Chairman of the Department of Architecture, Architectural Engineering and Planning in the University of Miami's School of Engineering and Environmental Design . . . **Gregory B. Baecher,** Ph.D. '72, Assistant Professor in the Department of Civil Engineering of M.I.T. for three years . . . **Rowland M. Cannon, Jr.,** '65, Assistant Professor of Ceramics in the Department of Materials Science and Engineering of M.I.T. for three years . . . **James L. Powell,** Ph.D. '62, Provost, Oberlin College . . . **Howard B. Bensusan,** '44, full Professor of Biochemistry in the School of Medicine, Case Western Reserve University . . . **Allan H. Clark,** '57, Dean of the Purdue University School of Science . . . **E. James Potchen,** S.M. '73, Professor and Chairman of the Department of Radiology at Michigan State University.

Albert C. Hall, Sc.D. '43, has been named to the Western Maryland College Board of Trustees . . . **Frank Press,** Chairman, Department of Earth and Planetary Sciences at M.I.T. has been elected as a councillor of the National Academy of Sciences . . . **Joseph I. Goldstein,** '60, full Professor of Metallurgy and Materials Science at Lehigh University.

Tang Hall Fire: One Student Is Dead

An intense, short-lived fire blackened the corridors of the 19th floor of the Tang Residence Hall on July 22, and Renato C. V. Ribeiro, a graduate student in physics, suffered burns which later proved fatal; he died on July 28 in the Burn Unit of Massachusetts General Hospital.

The fire appeared to have started at an end of the 19th floor corridor near the rubbish shoot, according to Cambridge firemen. It charred walls and ceilings in the corridor and was hot enough to melt plastic fittings on light fixtures, but damage was confined largely to the corridor. Mr. Ribeiro was found by Cambridge firefighters, who responded to an automatic alarm, unconscious in front of the elevators, and he was reported to have suffered second- and third-degree burns over most of his body as well as respiratory damage from heat and smoke.

Three others were also injured, less seriously: Charles A. Thomson, Manager of Westgate and Tang Hall; Manuel F. Sopas, maintenance mechanic at Tang Hall; and Owen L. Deutsch, '73, a graduate student in nuclear engineering. Messrs. Thomson and Sopas were admitted to Massachusetts General Hospital for treatment of burned hands and lungs which resulted when they were called to the 19th floor by the fire alarm system; Mr. Deutsch was burned on one hand when he touched the outside door of his apartment during the fire. Mr. Deutsch and several other residents were rescued from apartments on the floor by Cambridge firefighters, who also brought some ten residents of adjacent floors through the smoky stairwell to safety.

There was no structural damage to the 24-story building, and residents — except the 18 with apartments on the 19th floor — continued to use the building throughout the summer. □

Herbert B. Dwight, 1885-1975

Herbert B. Dwight, Professor of Electrical Machinery, Emeritus, who was associated with M.I.T. continuously from 1926 until 1971, died in Warwick, R.I., on June 30. He was 89.

Born in 1885, Professor Dwight was raised in Canada and studied at the University of Toronto (B.S., 1909) and McGill University (D.Eng., 1924). He came to the Department of Electrical Engineering in 1926, and he was an active member of the faculty from then until retirement in 1951. In that period he contributed extensively in the fields of electrical machinery, power transmission, and complex circuit computation. Following retirement he continued teaching at M.I.T. until 1956 and served Lincoln Laboratory as a consultant in computation and radio propagation research until 1971. □

Emery I. Valko, 1903-1975

Emery I. Valko, Research Associate in the Fibers and Polymers Laboratory of the Department of Mechanical Engineering, died suddenly in Belmont, Mass., on June 20. He was 72.

Dr. Valko was a key member of a group of scientists whose work in Germany in the 1920s and early 1930s laid the foundation of modern polymer chemistry. He was at that time co-author of a paper on the theory of rubber elasticity which has since become

generally accepted as the fundamental statement of the mechanism of deformation of all rubber-like materials.

Dr. Valko's work at M.I.T., where he came in 1964, was concerned with textile dying and with information systems for the textile industry. He was the author of four major books in the field of colloid behavior, and he held more than 25 patents.

A native of Budapest, Dr. Valko studied at the University of Vienna (Ph.D., 1929). He came to the U.S. in 1938 and his work for the Onyx Oil and Chemical Co. shortly thereafter led to germicides widely used by the Armed Services in World War II. Dr. Valko taught at Lowell Technological Institute before coming to the Institute. □

Deceased

Harry P. Sweeny, '08; May 12, 1975; 38 Oliver St., Rockland, Maine

Walter F. Connolly, '11; April 25, 1975; 16 Midvale Rd., West Roxbury, Mass.*

Harold B. Pushee, '11; June 11, 1975; 168 Conger Ave., Akron, Ohio*

Frederick H. Busby, '12; June 22, 1975; 144 Bellevue Rd., Watertown, Mass.*

Philip B. Terry, '13; March 22, 1972; 113 Free St., Hingham, Mass.

Stanley H. Osborn, '15; June 7, 1975; 36 Cobbs Rd., West Hartford, Conn.*

Charles B. Glann, '16; June 30, 1975; 161 East Sixth St., Oswego, N.Y.*

Emory L. Kemp, '16; May 19, 1975; Box #76, Wellfleet, Mass.

Herbert Mendelson, '16; June 3, 1975; 172 E. 64th St., New York, N.Y.

Jeremiah Reen, '16; April 28, 1975; 167 Springfield St., Springfield, Mass.

Chester L. Kingsbury, '18; June 28, 1974; 189 Court St., Keene, N.H.

John O. Merrill, '19; June 10, 1975; 101 Gardner Pl., Colorado Springs, Colo.*

Frederick J. Hopkinson, '20; June 2, 1975; 409 Riverside Dr., South Cocoa, Fla.*

Charles H. Reed, '20; April 5, 1975; 17852 Lake Ave., Cleveland, Ohio

Albert H. Tomlinson, '20; June 8, 1975; By the Way, Box 847, Pinehurst, N.C.

Edwin F. Delany, '21; June 12, 1975; 3300 Gulf Shore Blvd., No. 209, Naples, Fla.*

John J. Healy, Jr., '21; June 6, 1975; 1 Crescent Ave., Scituate, Mass.*

Lemuel Pope, '21; March 31, 1975; Del Mesa Carmel 266, Carmel, Calif.*

Robert S. Taylor, '23; June 14, 1975; 5704 Thames Dr., Austin, Tex.

James F. McIndoe, '25; April 15, 1975; 44 Santa Rosa Ave., Sausalito, Calif.

Arthur E. Larratt, '26; June 7, 1975; 2 Gothic St., South Paris, Maine*

William L. Taggart, Jr., '27; June 19, 1975; 27 Pinehurst Rd., Belmont, Mass.*

Carl Feldman, '28; June 30, 1975; 48 High St., Sharon, Mass.*

Thomas J. Raftery, '31; May 12, 1975; 3822 La Hacienda Dr., N.E., Albuquerque, N.Mex.

James R. Welch, '33; April 23, 1974; 81 Taylor Rd., Belmont, Mass.*

Charles F. Pentler, '34; February 19, 1975; 13261 Montebello Rd., Cupertino, Calif.

Otto R.B.L. Thelan, '35; November 23, 1971; 39 Seaview Ave., Marblehead, Mass.

R.C.W. Thelan, '35; November 21, 1974; 39 Seaview Ave., Marblehead, Mass.

George R. Weppler, '37; June, 1975; 28 Broadview Rd., Westport, Conn.*

C. William Guy, '39; April 10, 1975; 17230 Sunburst St., Northridge, Calif.

Robert O. Soman, '40; May 24, 1975; 40 W. 77th St., New York, N.Y.

Theodore G. Lindsay, '43; June 8, 1975; 3 Birchwood Ct., No. 4L, Mineola, N.Y.*

Sumner Ackerman, '44; June 10, 1975; 47 Gov. Bradford Rd., Brewster, Mass.

Helmut F. Onusseit, '48; July 1, 1974; 33 Barrows Rd., Reading, Mass.

George R. Higgins, '51; June 22, 1975; 81 Harlow Dr., Amherst, Mass.

George R. Roy, '52; May 30, 1975; Box 452, Katonah, N.Y.

* Further information in *Class Review*

Class Review

96

Richard O. Elliot of Maine is now the sole remaining member of the class. Reports of his activities and honors of recent years have been reported in these columns. His newest distinction is that of being the oldest alumnus of the institute. — **Clare Driscoll,** Acting Secretary, Cliff St., Plymouth, Mass.

04

I had a pleasant surprise recently, **Carle Hayward**'s son, wife and daughter visited his mother in Wellesley and they all came over to call on me. It was the first time I had met them and enjoyed the visit very much.

Leif Davis wrote concerning the activities of his father **Frank H. Davis**: "He is retired now as President of the Basin Oil Company and he is a director emeritus of Whitehead and Kales Steel Company and of Bethlehem Fabricators. I tend him, and we live in our ancestral home in Historic Indian Village, Detroit, Mich."

I must report the passing of two classmates: **Frank M. Chace** and **Frank W. Milliken.** I received these notices from the Institute with no details. — **Gene H. Russell, Jr.,** 82 Stevens Road, Needham, Mass.

05

There is no news to report concerning Alumni Day. I hoped that **Henry Buff,** who has an outstanding record of Alumni Day attendance, would be present and send a brief report of the doings.

Lloyd Buell's death was reported about a year ago but we had no details. **Roy Allen** sent me a letter he received from Lloyd's daughter Margaret (Mrs. H. A. Lusk, 5208 Beckford Street, Tanzana, California 91356) giving an account of Lloyd's last months and death. Mrs. Lusk's letter, dated June 28, 1975, explains that her father "had an accident in his car . . . He was driving to lunch and made a left turn and some youngster, going very fast, hit him. He was in the hospital only two or three days for his few cuts and a broken collarbone. But the shock, I think, brought out other weaknesses he was already developing, and a couple of days later he had to go back to the hospital for pneumonia, congestive heart failure, and prostate trouble. He was there a month that time. I was in El Paso with him six weeks, but on August 19 brought him to California to live with me. He grew progressively weaker and died on October 5, 1974, . . . His time with us here was short, but we loved him very much and he seemed happy to be here."

Frank H. Davis, '04, with his son Leif Davis

Roy Allen has the following comment about "Doc" **Warren Lewis:** "He truly was a great man and lived a great life. He and I were members of K2 8 at Tech but, as we were in different courses, I did not get to know him too well. But in 1918 when I was in Washington he and Bill Green came down on Chemical Warfare business. We got together and he told me somewhat of his work. I was interested, and though I had my commission in the Air Force, I tried to get transferred but without result. Thus my limited association with a man of world fame!"

Roy appears to be happy in his retirement home in Phoenix, Ariz., and is in reasonably good health. "No news with me," he writes. "I still get around with assistance of my 'third leg,' take care of my apartment (except for the fortnightly house cleaning), and get my morning and evening meals. There is plenty of entertainment and other distractions to interfere with things I should get done!"

Herman Eisele writes: "On December 31, 1974 I gave up my office in the Engineers Bldg. in Cleveland, where I was a consulting engineer for 66 years. I specialized in the design and construction of production machinery and facilities, both mechanical and structural. I retired to my comfortable apartment at 2657 Noble Road, Cleveland Heights, Ohio 44121. At 93, my health is fairly good under the meticulous supervision of seven medical specialists."

It was a privilege to telephone **Gilman Joslin** last spring. Gilman is in the Florida Manor, 830 W. Michigan Avenue, Orlando, Florida. He has a private telephone — (305) 843-4526 — and would enjoy talking with any classmate within phoning distance. Gilman is 94 years old and says his health is excellent but his eyesight is almost gone — so he cannot read or write.

Isabelle Prentiss says that husband **George Prentiss,** who is 93 years old, "enjoyed for all these years the communications Goldy was so faithful in sending to the *Tech Review*." **Bill Spaulding** also wrote regarding Goldy: "Fred was a wonderful secretary, held the Class together, and we all will miss him." About himself, he says: "Alice and I keep reasonably well for our 183 totalled age but stay close to home and get deafer and slower daily."

Gilbert Tower appears to be one of our most active classmates in civic and personal affairs, in spite of physical handicaps. The following is taken from the February 13, 1975 *Patriot Ledger* of Quincy, Mass.: "At 89, Gilbert S. Tower is the town's most active gadfly, with a particular emphasis on getting the planning board to complete its zoning bylaw amendments quickly. . . In April, 1972, the selectmen appointed him 'honorary town engineer' because of his professional background as a naval engineer and in recognition of his active participation in town matters. . . He is married to the former Elizabeth Osgood, another Cohasset native, and they have four children. He has been acting fire chief, 'town bellringer' and was an elected planning board member between 1968 and 1970."

The money given by class members for the Fred Goldthwait Memorial Fund has been sent to the First Unitarian Society, Laconia, N. H. I would like to share part of Ruth Goldthwait's letter to me: "What a fine contribution in memory of dear Fred. I am sure he would not only be pleased but surprised. He was such a humble person as regards his accomplishments . . . the Class '05 Memorial to the First Unitarian Church, has brought the total Memorial and Scholarship Fund to $600.00. There has been over $200.00 sent to the Friends (Quakers) Meeting — also money to our Library plus two very fine books and some money to the Grange. I am deeply touched by the outpouring of love."

Peggy and I have been spending a few

weeks among the beautiful mountains of Franklin, N. C. We expect to do a little visiting with kinfolk and friends in the Long Island Sound area before going home. I wish to express my sincere thanks to all my classmates for their wonderful help. Please keep the letters coming. — **William G. Ball,** Acting Class Secretary, 6311 Fordham Pl., Bradenton, Fla. 33505

07

Kirk Dyer reports attending his 70th reunion at Cal Tech, his first alma mater. There he received an award from the President for being the oldest alumnus.

An article in the *Villager* of Newton, Mass., on April 10, 1975 told that **Milton E. MacGregor** "is a 'young' man at age 90 and a most unusual one."

The reason? In the June issue of the *Review* we noted that he had just finished weaving material for a dress for his wife and daughter. Mr. MacGregor is also an athlete. "Mr. MacGregor was the first manager of the 'Hut System' for the Appalachian Club back in 1921 and headed this work up each summer until it became a full-time job several years later . . . He has been inducted into the 4,000-footer club of the Appalachian climbers and last summer he completed trails and paths around Mt. Washington with his daughter, Mrs. Crooker, and Mr. Crooker." He has climbed all 48 mountains in New Hampshire. "In addition to his continuing interest in mountain climbing, he is an active bowler, and plays chess and bill. When he was 82, he set the season's high at the Orleans bowling alley for candle pins." Mr. MacGregor resides at the Baptist Home of Massachusetts in Chestnut Hill. — S.F.

09

This year — our 66th anniversary — only two signed up for Alumni Day, **Art Shaw** and **Chet Dawes.** Muriel Dawes and Margaret Davis also attended. Art Shaw writes: "I was sorry to miss Alumni Day but the combination of weather and Betty's indisposition made it it expedient to cancel my plans. Next best to being there was Margaret Davis' report of the various features which she attended with you. It was very thoughtful of her to do this. I was remiss in not writing you as usual during our winter in Florida. Actually, we lived so quietly this past year that there was not much to write about. I attended a couple of meetings of the M.I.T. Club of Southwest Florida where it is always pleasant to find a few old acquaintances. I trust you will have a pleasant summer in Maine and a good rest from your amazingly active professional occupations." We were most sorry to learn of Betty's indisposition. Over the years she has rarely missed attending Alumni Day and our many reunions.

The Alumni Program began Thursday evening, June 5, with Tech Night at the renowned Boston Pops at Symphony Hall, with Arthur Fiedler conducting. On Friday morning there was a panel presentation by members of the faculty on the impact and relation of their disciplines to the solution of societal problems. As usual, the class secretaries were invited by the *Review* to meet in a room in the Student Center with the Board of Editors which included John Mattill, Editor-in-Chief; Susanne Fairclough, Marjorie Lyon, and Chris Santos. Marjorie, who has been our editor these past years and was most most helpful, has been promoted to work with John Mattill. Susanne Fairclough is taking her place. This year many of us were disappointed that the usual alumni luncheon was replaced by a box luncheon in Rockwell Cage.

The Memorial Service for M.I.T. Alumni who passed away during the past academic year, held in the Memorial Chapel, was conducted by Robert L. Meier, '44, with John Cook as organist. The members of '09 listed are as follows: **John W. Beal, Henry C. Colson, Jr., Bradley Dewey, Frederick A. Fenger, Charles Freed, Austin B. Henderson, Barry H. Jones, Arthur R. Knipp, Robert C. Latimer, Archie McEachern, Clyde W. Osborne, Paul Remick, Dwight W. Sleeper.**

It is with regret that we print these additional obituaries: **Barry H. Jones** on December 25, 1974, of Poughkeepsie, N.Y. He prepared at Riverview Military Academy. . . . **Reginald W. Millard** died May 7, 1974; he prepared at Hamilton Collegiate Institute, Ontario, Canada. At the Institute he was a member of the Mechanical Engineering Society, Tug-of-War, Assistant Art Editor for *Technique,* on the Class Day Committee.. Our records show that after graduation he held industrial positions in Toronto, Canada, was a Lieutenant Commander, Naval Service Headquarters, Ottawa, Canada, and his last address was North Vancouver, B.C. . . . **Clyde W. Osborne,** died May 30, 1973, at Portland, Ore., where he lived most of his life. . . . **William M. VanValkenburgh** died August 1, 1971, at Conway, Ariz. We have no information on his career. — **Chester L. Dawes,** Secretary, Pierce Hall, Harvard University, Cambridge, Mass. 02138

10

Those attending our "mini" 65th Reunion on Thursday, June 5, at McCormick Hall, M.I.T. West Campus, the same location as our 60th Reunion, were **Jack Babcock, Art** and Mary **Curtis, John Gray** and his son Robert, **Ralph** and Meta **Horne, Carl** and Glenna **Lovejoy,** and **Fred Lufkin.** The 1910 program included a Class Luncheon and a Class Dinner — with lots of opportunity for informal "get-togethers" before, between, and after our scheduled meals. Our class is one of the few (perhaps the only one) which has held an official 65th Reunion!

Ralph Horne, our president since the death of **George Lunt** in 1973, welcomed us. Then Jack Babcock, Reunion Chairman of the Class since 1955, presented some of the "highlights" of the Class and of our quinquennial reunions at Chatham Bars Inn (Cape Cod); Charterhouse Motel (Route 128); Hotel Continental (Harvard Square, Cambridge); and our 60th at McCormick Hall. The Class of 1910 entered M.I.T. with 466 members, of whom about 300 received degrees. Today we have about 50 classmates living whose addresses are known — about 10 per cent of our entering class in 1906. He also spoke briefly about several classmates who served as our officers for many years. These included **Frank Bell,** class president for our first 40 years; **Dudley Clapp,** our secretary for over 30

Members and wives of the Class of 1910 at this summer's 65th Reunion. Left to right: sitting — Mrs. Horne, Mrs. Curtis, Ralph Horne, Mrs. Lovejoy; standing — Fred Lufkin, Jack Babcock, John Gray, Arthur Curtis, Carl Lovejoy.

years; and **Herb Cleverdon,** our secretary since then. In conclusion, he gave us considerable information about the 34 classmates and guests who attended our 60th Reunion — of whom only 10 were able to be with us this year.

The only item of business at the Class Luncheon was the election of class officers, who will serve permanently, except when unable to do so for reasons of health. The list is as follows: *President,* **Ralph Horne;** *Vice President,* **Arthur Curtis;** *Honorary Secretary,* **Herbert Cleverdon;** *Class Agent* and *Secretary,* **Jack Babcock;** *Estate Secretary,* **Walter Spalding.**

After our Class Dinner, another enjoyable affair, several of our group left to attend "Tech Night at the Pops"; the others had another fine evening together in the parlor assigned to 1910. On Friday most of the 1910 group attended seminars arranged by the Alumni Day Committee; a final event of the day was a banquet arranged by the Civil Engineering Department for M.I.T. graduates of that Department and for present and former members of the staff; Jack Babcock was the guest of honor.

According to the M.I.T. alumni records, several 1910 classmates have passed away who have not been previously reported here, as follows: **Otis S. Smith,** November 27, 1972; **Walter R. Dray,** April 1, 1973; **Charles A. Robb,** April, 1973; **Murray H. Mellish,** February 1, 1975. Here are some notes about Murray Mellish, who was born March 27, 1885, at Hebron, Nova Scotia. He resided in Malden, Mass., for about 50 years prior to his death. His wife was the late Eva A. (Fulton) Mellish, whom he survived by about 3 months, and he is survived by his only daughter, Mrs. Elise M. Vaile of Palm Springs, Calif.

Murray Mellish spent much of his professional life as an engineer upon projects pertaining to public works, such as water supply, water power, sanitation, surface drainage, and flood control. During his long career he was employed by the U. S. War Department, Construction Division; the Corps of Engineers, U. S. Army; the U. S. Geologic Survey, Water Resources Branch; the Federal Public Works Administration; and such well-known engineering concerns

including Barrows and Breed; J. G. White Engineering Corp.; Weston & Sampson; Stone & Webster Engineering Corp.; Chas. T. Main, Inc.; and Fay, Spofford & Thorndike, Inc. Following his employment with Fay, Spofford & Thorndike, Inc., he retired from active professional practice about 15 years ago.

Please send future Class Notes items for *Technology Review* to: Professor **John B. Babcock III** (our permanent Class Agent and Secretary), 33 Richardson Street, Portland, Maine 04103

11

We regret to report the passing of two classmates: **Walter F. Connolly** on April 25, 1975; and **Harold B. Pushee** on June 11, 1975.

Mr. Connolly was a teacher at the Boston Trade School until he retired in 1958; and was married to Mrs. Alice A. Connolly for 56 years, who survives him.

Mr. Pushee lived in the Akron, Ohio area and had worked as a chemical engineer for General Tire. He is survived by his wife, Angie. — S.F.

12

At the annual Alumni Reunion in early June this year, although there was a record attendance, I regret to report that **Phil Dalrymple** and his wife were the only others from the Class of 1912 who were with me. We attended the crowded Pops Concert, the class luncheon, and buffet. I was adopted by the Class of 1920, and shared their celebration program which included a three-hour cruise around Boston harbor, where I once spent much time in my sloop.

In June, **Jonathan Noyes** visited me for several days at my home in Swarthmore. We had the opportunity to reminisce about the good old days at Tech and recalled many classmates. While here John attended the wedding of an old friend and then left for Washington. He has since gone up to his cottage in Brooklin, Maine, where he has summered for many years since his youth. . . . I received a letter and clipping from G. Malcolm McNeil, who though a 1926 graduate, was a business associate with me. We also used to ski together in the White Mountains. He reported the arson of the Redstone Covered Bridge, Conway, N.H., on July 4 this year by local youths and the community is much disturbed. The bridge was built in 1846 and is two span. It has been kept in excellent repair and has a Paddleton, braced truss, the first of its kind. It is one of a very few on a state road and, I think, the first covered bridge I ever photographed. Mac now lives in Conway during the summer, but goes to Venice, Fla., for the winter. . . . **George Uman,** a special student living in Los Angeles, Cal., writes briefly that he and his wife are celebrating their 60th anniversary this year. Our congratulations, George!. . . . A newsy letter was received from **Billy Reeves** of Palmerton, Penn., saying that he is in good health and spends most of his time maintaining his home and grounds. He has discontinued his long drives in the middle west, however, due to the generally poor health of his wife, Bea, for the past year. Billy reports the birth of his first great-grandson. His son has been in the administrative branch of the Army, for the past three years at Fort Meyers, Va., but expects this will terminate in December. His other son, Tom, travels a great deal for E. F. Hutton and Co. from New York to Phoenix, Ariz., as Director of Investment Strategy.

Jim Cook, '12, orders dinner at Snow Inn, 40th Reunion, 1952

I regret to report the death of **Frederick Busby,** which occurred quite suddenly, in Watertown, Mass., on June 22, 1975. Fred was one of our most loyal classmates and never failed to attend our every meeting. Early in his career, he became an accountant at M.I.T. where he remained for several years. He then accepted a position as manager of the M.I.T. Credit Union for years and more recently has been a teacher at a private school. He is survived by two daughters, one of whom lives in Tallahasee, Fla., and the other in Watertown. A sister lives in Arlington, Va. There are also many grandchildren. The class sends its deep sympathy. — **Ray E. Wilson,** Secretary, 304 Park Ave., Swarthmore, Penn. 19081

13

We are very grateful for the letters of **Henry Glidden** and **Charlotte Sage,** as well as the phone call from **Frank Achard.** They reported that several of our regular '13ers attended the Alumni luncheon: Jane and **Heinie Glidden, Charlotte Sage, Walter Muther** and his daughter Sally Lawton, **Frank Achard, Burton Cushing, Warren Glancy.** Evidentally, the Capens were missed, and we appreciated that.

Herbert Shaw writes: "Last October I was asked to join a group of men known as S.C.O.R.E., or Service Corps of Retired Executives, which is part of the Small Business Administration, and was set up to give advice to small businessmen who are in some trouble over money or management. We give free advice only, which they can follow or not, as they see fit, or as they are able. We meet in the boardroom of the New Haven Chamber of Commerce. The members are all retired businessmen who are willing to give their time once a week to the project. Our New Haven, Conn. group has a bank board chairman, the president of the largest factory in New Haven, a top flight steel salesman, a M.I.T. man, a C.P.A., and a few local businessmen who were smart enough to start a business and build it into a paying company. . . . Oh yes, we have one professional woman. It is a great pleasure to work with such a nice group. Every time I come home from a meeting I am sure I have done my good deed for the day. If anybody is wondering how to spend a few hours a week, I would like to suggest that he look into this as a good way to put in a little of his time. . . . I am very well and active now, but Leila is quite lame with arthritis in her knees. She still continues with her Woman's Club Work."

Stanley Parker writes us advising of the death of his wife. We extend our heartfelt sympathy to you, Stan. He writes: "I am sorry to report that I have lost my darling Louise. She died suddenly in her sleep after a long illness. We had been married 59 years. She was a great friend of "Howdy" Rand, who introduced us in 1910 and was my best man when we were married in Trinity Church, Boston. . . . Give my best to "Roz" and the others of our class and especially to you for doing a great job. . . . I am fairly well and at present recovering from a cateract operation which accounts for the poor writing."

Again, we were very glad to receive a note from **Allison Butts.** He enclosed a death notice of **Paul. V. Cogan.** We are sending a note of sympathy to his wife, Arlyle. The death notice reads, in part: "Before retiring 26 years ago after 35 years of service, he was resident manager of Bethlehem Steel Corp. He was a member of St. Anne's Catholic Church, Bethlehem. A graduate of Massachusetts Institute of Technology, he was a member of the Lehigh Valley M.I.T. Club, the Boston Yacht Club, the Saucon Valley Country Club, and an honorary member of the Danish Yacht Club. He was also active in the Bethlehem University Club and second president of the Macada Road Assoc. Memorials may be sent to the Heart Assoc." — **George Philip Capen,** Secretary and Treasurer; **Rosalind R. Capen,** Assistant Secretary, Granite Point Rd., Biddeford, Maine 04005

14

In August, **Herman Affel**'s wife, Dorothy, sent me Herman's Notification of Appointment, signed by Dr. Maclaurin, as a Research Assistant in the Electrical Engineering Dept. for the nine months from October 1, 1914, to July 1, 1915. The notification, and a covering letter from Dr. Pender, then the head of the E. E. Research Div., have been forwarded to the M.I.T. Historical Collections.

In response to my plea for news, **Ray MacCart** wrote early in July that there wouldn't be any news in his letter because he "hadn't committed a murder or broken a leg yet, but one can never tell what may develop in the future." . . . **Alden Waitt** wrote that his spring and summer were completely occupied with the construction of the new building of the San Antonio Art Institute and raising money for equipping it. He'd had little time for his own painting, couldn't get away even for a week, and felt he had a bear by the tail. Those of us who know Alden and what he has done can suspect that actually he has the bear well leashed.

Walter H. Leathers died in a hospital near his home in Hingham on June 25, 1975, at the age of 85, after a brief illness. Johnny, as he was always known to his classmates and other friends, was in Course II with us in our last three undergraduate years. He then spent several years with a scale manufacturer, a few years with the former Niles, Bement, Pond Co., and later was a consultant to investment firms in New York and in Boston. For the past 40 years Johnny had lived in Hing-

ham, and for most of that time was a manufacturer's representative for Dollin Corp. and for Stella Products Corp. In 1972 he was covering a territory extending a hundred miles from his home, and enjoying driving 500 miles a week. He retired only last year. Johnny was a founder of the Veteran Motor Club of America and for many years drove his 1904 Northern car in the Hingham Fourth of July parade. If I recall correctly what he told me a few years ago, that was the car on which he learned to drive in the year of its manufacture. He was a member also of the Massachusetts Historical Society and of the Hingham Yacht Club. In a letter of affectionate reminiscence of their student days, **Roy Parsell** wrote that he and Johnny ran their theses together, "An Efficient Boiler Test," at a then-new plant of Narranganset Light and Power Co. in Providence. They recruited a lot of M.I.T. students to read gages and make calculations. Roy described it as "a wild time," ending with a 4 a.m. steak dinner provided by the power company. Roy mentioned also their experiences as driver-guides of Royal Blue Line sightseeing buses on tours of Boston and to Plymouth, Concord and Gloucester. Johnny is survived by his wife, the former Claire Donohoe, whom he married in 1918, by two daughters, Mrs. Philip W. Boardman of East Orleans, Mass., and Mrs. Davis B. Keniston of Perkinsville, Vt., and by ten grandchildren and a great-grandchild.

Harold A. Mayer has a new address: Commodore Hotel (Room 226), 1609 S. W. Morrison, Portland, Ore. 97205. — **Charles H. Chatfield,** Secretary, 177 Steele Rd., W. Hartford, Conn. 06119

15

1915 is still the Class Supreme. Our 60th Reunion brought out 65 for cocktails and 51 for dinner following — a remarkable attendance including many wives, family members and their guests from all over the country; many of whom we had not seen for a long time. All these old friends joined to make it a gay and memorable party. It was a pleasure to have with us several widows, wives and sons and daughters of classmates. Ethel Rooney and Barbara Thomas did a fine job as hostesses. Joyce Brado, our Class Agent came from Lockport and enjoyed meeting the classmates she corresponds with. Earlier in the day at the Alumni Lunch, the family of our deceased classmate, **Mitchell B. Kaufman,** presented a $100,000 gift to M.I.T. for scholarship aid, with special consideration for minority groups and American Indian and Spanish American students. Mitch's sister, Mrs. Albert H. Webster (Al is 1921) attended our cocktail party.

Bob Welles, in France with his daughter, wrote that they had been driving through the old chateau country, where his family lived while he was at Tech. His touring included a drive through a seven mile tunnel under Mt. Blanc over the St. Bernard Pass into Switzerland. . . . In the June issue of A.S.C.E. **Phil Alger** wrote: "The human element of engineering has been neglected. Engineers, young and old, can learn much from the fascinating lives of past engineers. Such models can stir the imagination and impart a side of engineering not always found in textbooks." . . . Joyce Brado wrote to thank the Class for inviting her to Alumni

Azel Mack, '15, proudly announces Class Gift total of $140,000

Day and express the pleasure of being with us. . . . **Gil Peakes** took some pictures at the Reunion which we circulated. **Alton Cook** and the Peakes were neighbors many years ago in Bloomfield, N.J. . . . **Henry Daley** wrote: "**Sol Schneider** phoned and gave me a glowing report on the successful cocktail party and dinner you ran for the Class. He mentioned particularly the presence of **Mary Plummer Rice,** Joyce Brado and of course Barbara. He also mentioned, among others, **Frank Murphy,** who came up all the way from Florida. I was sorry to learn of **Harry Murphy**'s death in the current issue of the *Review*."

Our Class President, **Jack Dalton,** wrote a fine letter: "The party for our 60th which you and your helpers arranged was a smashing success, saddened by those who could not be with us but joyful for those who could and that was a surprising number. The arrangements were perfect and I am sure the end — the dinner just topped it off. The reunion was made all the more significant by the Kaufman Foundation's munificent gift which, with the generous $40,000 in other gifts, made a total of $140,000 from 1915; something of which the Class supreme can be proud." We are proud of Jack's Class leadership and inspiration. . . . **Dinger Doane** wrote from Santa Clara, Calif., "Some country out here, but so is New England."

Our sympathies go to **Ellis Ellicott** whose wife, Emily, died in Baltimore on May 26. . . . **Herman Morse** of Akron wrote: "Now that we are back in Akron from our wonderful 60th Reunion trip, followed by one to Atlanta to see our grandson graduate in law from Emory, Marjorie and I want to thank you and your associates for the wonderful dinner and Happy Hour with 1915 classmates, families and friends." . . . **Gil Peakes** of Metuchen, N.J., wrote: "Mrs. Peakes and I very much enjoyed the class reunion and to meet again with you and the oldtimers of '15 who braved the cold weather and the infirmities of old age to get together for a feast. This was my first visit at the Faculty Club. It reminded me very much of previous class meetings at the Chemists Club in N.Y. Thank you for making such good arrangements this time. I wish to tell you of my appreciation of your dedicated efforts to keep the '15ers together and functioning as a group, over these many years. You should now be entitled to a generous pension. Mrs. Peakes may have told you of our coming celebration of 50 years married, on July 11. The actual wedding anniversary is June 29, but due to date conflicts we put the celebration off a few days. What are a few days, in a span of 50 years?" That "pension" Gil speaks of is the close and fine friendships I have in our Class beyond all evaluation!.

Mary Plummer Rice, our outstanding coed, was with us at the 60th reunion, and then took off for six weeks in London. How she does get around! . . . **Chet Runels'** widow, Margaret, wrote from Lowell, Mass.: "Chester had many dear friends in '15, and I remember them with affection. Please give my warm greetings to all." . . . **Cliff Sifton** is recovering from being laid up a long time with a fractured hip. He says he can now walk short distances with a cane. We're sorry for you Cliff and all the best for a speedy and complete recovery.

Stanley Osborn died June 7 in Hartford, Conn. He had always been a regular and loyal supporter of Class and Alumni activities and attended all the Class Dinners in Boston and New York. *The Hartford Times* wrote a splendid obituary: "Dr. Osborn was the state health commissioner for 37 years and the time of his retirement in 1959 was the longest serving commissioner in the state and possibly the country. He campaigned vigorously during his years as health commissioner to get local communities to fluoridate their water supplies as a preventative for tooth decay. Known as 'the dean' of state health commissioners, Dr. Osborn belonged to and was active in practically every medical and public health organization in the country. Dr. Osborn's only prescription for health was prevention and control of disease and he believed that public health should be gained through education rather than compulsive legislation.

"Dr. Osborn received many honors and awards during his public health career beginning in World War I when he joined the American Red Cross Sanitary Commission to Serbia. The team was sent there to assist in the outbreak of typhus and other contagious diseases sweeping the country. Dr. Osborn was graduated from Tufts Medical School in 1914 and the joint Harvard/M.I.T. School for Health Officers. Among his many awards, Dr. Osborn won the highest tribute that can be given to a public health officer in New England. He was a lecturer and professor at Yale Medical School. In 1965, several years after his retirement, Dr. Osborn was honored by the state departments of Health and Mental Health with the dedication of the Stanley H. Osborn Library at the state health building in Hartford." The sympathy of our Class goes to Stan's family.

Carl Wood, bowled in a lawn bowling tournament against Canadian champions at Spaulding Club Inn, Whitefield, N.H. Some athlete for his age! **Azel Mack,** Secretary, 100 Memorial Dr., Cambridge, Mass.

'25ers sight Boston skyline

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You will be pleased to know that we have already made our reservations for our 60th Reunion at the Chatham Bars Inn. Our class will be there on June 1 to 3, 1976. At the same time, the Class of 1926 will be there celebrating their 50th. We're going to try to make it as convenient and easy to attend for all who are able and interested. If it makes sense, we'll have a chartered bus again as we did at our 50th and 55th for the roundtrip from Boston to Chatham. Alumni Day is on Friday, June 4, and we can make arrangements for free dormitory accommodations for the nights of June 3 and 4. Pops Concert again will be held on Thursday night June 3. We'll develop and report the details of the reunion plan as the year progresses. In the meantime, you now know the dates and can begin to make your own plans. Remember, we want to help in any way that we can to make it convenient and comfortable for all to attend. Perhaps our attendance goal should be "Sixty for our Sixtieth." We know that not everyone will be able to come, but wouldn't it be nice if we could find some way so that all of us could share in this extraordinary achievement. Let's have your ideas.

We were pleased to get this news from **Fred Upton:** "In December, we moved from our white elephant into a much smaller house. It's all on one level, making it easier for Elizabeth who broke her hip three years ago and can't navigate stairs easily. I cracked a rib in October but that didn't keep me out of action very long." . . . We had a couple of nice letters from Isabel and **Ralph Forsyth** in which she wrote in part: "We are so glad we made the reunion luncheon. It was fun and very well planned. It was nice for me, meeting the men and their wives whom I had read and heard about for many years. It was Ralph's only trip of that distance in over five years — driving I mean; of course, we fly to Florida each winter. So thanks for making your letter of May 22 persuasive enough to spur him to the effort. We enjoyed the reunion picture. That's some special photographer who could make us look that well!" . . . **Charlie Lawrance** was still in the hospital in early July and holding up well. Charlie and Lois have been regular attendants at our reunions, but this year with their plans all made to attend again, Charlie developed an ailment which hospitalized him two days before the reunion. . . . Had this nice letter from **Paul Austin** in San Francisco: "Under a separate cover I am sending you a copy of the Arthur G. McKee and Co. house organ, which contains my picture and a short account of my appointment to the San Francisco Waste Materials Review Board. . . . Last February I received notice that I had been appointed. I went to the City Hall, and with three other technically qualified men was sworn in at the office of the Chief Administrator. . . . Sometimes the San Francisco sewage treatment plants encounter difficulties in treating the sewage. When this happens the authorities cite the industry causing the trouble and tell them to 'cease and desist.' They then have the option of doing as they are told or appealing to the Waste Material Review Board. We sit in a court room, at the Judges' bench, with the appellants' attorneys and the city officials arguing the case outside the rail. In a recent case we held four hearings and settled the case by giving the appellant four years to lower the PH by using detergents with a lower PH, as they are developed by the detergent manufacturers. As for me, I am still working at Arthur G. McKee and Co. in San Mateo. I go down in a car pool every day, over freeway 280 which is a beautiful drive through the hills, part of the way past Spring Valley, which stores San Francisco's water supply."

From the article which Paul enclosed we abstracted the following information on Paul's work with Arthur G. McKee's Company: "At McKee, Austin's most recent assignment was the Kennecott Copper Corporation smelter emission control project in Magna, Utah. His professional experience has included a wide variety of domestic and international engineering and construction projects. He has demonstrated technical expertise in the engineering and design of piping systems for metallurgical processing complexes, chemical facilities, refineries, and steam power plants. He has been responsible for developing new machinery for improved process designed vessels and welded mechanical structures, and successfully executed the engineering and design pipelines and associated pumping stations. He has served in the capacity of senior mechanical and piping engineer, supervising engineer, process engineer and consultant."

Jack Camp writes: "Many thanks for your kind letter of June 20 with the photo of the last Class Reunion, which I was unable to make. My congratulations to all those who did attend, who appear to be in fine condition." . . . On August 16, Frances and **Paul Duff** celebrated their 50th Wedding Anniversary. With 10 children and 41 grandchildren (and still counting), the Duff Homestead must have been a pretty lively place on this wonderful occasion. Congratulations, Paul and Frances.

We are saddened to report the passing of our beloved classmates — **Dick Rowlett** in June; **Dave Shohet** June 25, 1975; **Charles Glann** June 30, 1975. With all of us in the 80s and one of us, **J. Spotts McDowell,** in the 90s, we still have 149 classmates on our roster.

Again, we look forward to your cards and letters. Keep writing. We also wish all the health, and we hope that we will have the pleasure of shaking your hands at our 60th. — **Ralph A. Fletcher,** Acting Secretary, H. E. Fletcher Co., West Chelmsford, Mass.

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Alumni Day activities included '17ers: Beadles, Dunnings, Hunters, Lunns, and Ray Stevens. The Memorial Service was well attended. The attractive booklet for the service contained the names of eighteen of our classmates who had died in the past year. One of those booklets is mailed to each of the widows of record. Inadvertently our notes have not recorded the death of **Clair Turner** who died last December 7. He had been a leader in the developing health sciences, and his activities had been recorded in the last February issue of the *Review*.

Ossie Holt from California paid a June visit here to attend a family reunion. It was good to talk with him. He is a lawn bowling enthusiast, as is **Howard Melvin** whom he has met in competition.

Last spring there was word of Ruth Dennen having had a massive stroke. There was no specific news of her other than that she was in a Scranton hospital. It is recently learned from Bill Jr. that she is now in a Scranton nursing home with complete paralysis of her right side, comprehending speech but unable herself to talk.

It is good to hear from **Larry Clayton,** who writes from Jacksonville, Fla.: "I've allowed myself to be sidelined from practically all activities for the past ten years due to my own and my wife's infirmities. My wife, the former Emily Cormey of Belmont, Mass., died in January, 1973. I had been blessed by her companionship for over 53 years. I sold our home in Winter Park and moved here to Wesley Manor Retirement Village. Since then I have resumed travel occasionally, mostly to visit my daughter in Andover, Mass. I read, a bit enviously, of the doings of the most lively among my classmates; and sadly, of the frustrations of those who have slowed down, and those who have passed on." For those who have our "Thirtieth Anniversary Report" at hand, Larry's military record will be found interesting.

Our Assistant Secretary, **Richard Loengard,** has been doing some Massachusetts traveling, and reports: "My wife went back to her 55th reunion at Wellesley and has since taken over a job previously filled by 'Steve' Leonard, a classmate married to **Paul Leonard.** As we were going to the Cape we arranged to visit Paul and Steve at Lakeville, Mass. We found Paul very much on the ball at the age of 86, very trenchant and accurate about men we knew in the years since 1917, and leading the life of a farmer on some 150 acres of lush ground a bit north of New Bedford. We had a great chance to reminisce while Midge and Steve discussed matters relating to the Wellesley of 1920. Paul has had some six operations in the last few years, which is why he hasn't come to any of the reunions, but I think there is the possibility of his coming to our 60th."

Al Lunn and **Tubby Strout** had their usual summer lunch with **Ray Brooks** at Falmouth, Cape Cod where Ray almost without fail spends a month each year. **Penn Brooks,** responding to the remarks in the May notes, comments that he'd like to get that contributor down to Virginia and show him what a real stock farm looks like. **Leon Keach** observes that the once comfortable number of classes whose notes precede ours in these pages "seems to have diminished, and one day ours will head

the list, perhaps for many years, if everybody lives right and votes Republican." — **Stanley C. Dunning,** Secretary, 6 Jason St., Arlington, Mass. 02174; **Richard O. Loengard,** Assistant Secretary, 21 East 87th St., New York, N.Y. 10028

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Some weeks ago I visited the M.I.T. Historical Collections and noted that the final Alumni banquet, celebrating the moving of the campus to Cambridge in 1916, was held at the Boston City Club with a cost of two dollars per person. I reflected on the monetary difference of the then and now — and started a train of thought in a similar direction. Science and technology are on the defensive — much of the product of our hands and minds can be used for destructive purposes. Is there a missing ingredient? What improvements in education and training in government can better prepare us for the decision making process in the social problems of environment, poverty, and priorities in the use of resources? I invite your comments.

Jim Bugbee had the distinction of coming the greatest distance for Alumni Day. I enclose his interesting note: "First, let me say that the real highlight of my first M.I.T. Alumni Day was the dinner at the Faculty Club. The unique character of our great Class of 1918 (two years in Boston and two in Cambridge) and the outbreak of World War I as we were assembling as freshmen have always made me feel proud of belonging."

It is interesting to see that **Bennie Whorf** still has influence in the field of linguistics. A reference to him was made in the book, *After Babel: Aspects of Language and Translation, by George Steiner,* reprinted herewith are two paragraphs:

"Since the Eighteenth Century linguistic theory has been intimately associated with epistemology. Steiner summarized the history of this association as a dialectical process, a protracted contest between 'monadists' and 'universalists.'

"In the Twentieth Century the principal representatives of these two positions are the late Benjamin Lee Whorf and Noam Chomsky, of M.I.T. Whorf was one of that class of linguists who in their daily work actually dealt with real speech. Through a comparison of unrelated languages (such as the Indo-European family, exemplified by English, and several Indian languages, such as Shawnee and Hopi), he concluded that a person's "world view" is inevitably determined by his language, that his language shapes his thought in ways he cannot control or even perceive. Each language provides its speakers with a unique perspective; in the word resides the ultimate cultural bias."

On September 21 we will have our sixth mini reunion at Endicott House. Our special guest will be former Prexy Jay Stratton — wish all of you could be present for a wonderful afternoon.

Faithful **John Abrams** penned this note: "My wife, Evvie, while perusing the current *Review*'s column by Seltzer, said, 'Why, I thought **Sam Chamberlain's** praises now are history. Read this!' And there was a masterpiece of re-write of the muddled draft I sent you, oversentimental, maybe, but excised the way Sam would have liked it.

"Some time ago Evalyne's perceptive eye caught the title of a book carrying your surname as co-author with I believe William H. McAdams, '17, and Walter G. Whitman, '17. She's still curious. Need I comment on the sudden, overwhelming loss, within the short span of a few months of Warren K. Lewis, '05, William H. McAdams, and Walter G. Whitman; that triumvirate of the best of Technology greats, and of their contemporary the late Professor William H. Walker. I could tell some tales of his retirement in California where I saw him often."

We had a most pleasant interlude for a weekend in middle July when Dorothy Rossman visited us and the Howes. An added dividend of pleasure was a dinner at General Glover Inn on which occasion Narcissa Chamberlain joined the party.

Sax Fletcher suffered a heart attack on July 3. I am glad to report that he is making a good recovery — our prayers go out to him for a continued improvement to normalcy. . . . Mary Mead reports that **Ed Mead** is confined to the Carleton Convalescent Hospital in Fairfield, Conn. — again our prayers for good health.

Al Walker is battling as indicated in his short note: "I am badly crippled in both feet, due to gangrene. My doctor complimented Mrs. Walker for her success in clearing up the gangrene, but I still have difficulty walking but perhaps will be cleared up in some months." . . . **Wendell Monroe** asks a philosophical question — have any of you the answer? "Is there any scientific evidence that a person has a life after death? This question occurs to me since my life on earth will soon be over. I am 81 years old."

Don Goss — a real gentle soul — made his peace with his maker on July 14. We reprint the notice in the *Boston Globe:* "A native of Lynn, Mr. Goss lived in Swampscott 30 years before moving to Marblehead in 1965. He was an architect, with offices in Boston, Swampscott and Marblehead, who designed many houses on the North Shore. Mr. Goss was graduated from Massachusetts Institute of Technology in 1918. He was a member of the American Institute of Architects, the Massachusetts Architectural Assn., the Whiting Club, Wayfarers Lodge of Masons in Swampscott and the Marblehead Arts Association. He had been active in the Boy Scouts movement and served in most adult offices with the Boy Scouts of America from scoutmaster to commissioner of the North Bay Council. He received the Silver Beaver Award from the B.S.A., the highest a scouting official may receive. Mr. Goss was a former member and president of the Swampscott Parent-Teachers Assn., was an active member of the First Church, Congregational, in Swampscott, and was a former deacon and trustee of the church. During World War I, Mr. Goss served as a lieutenant in the U.S. Army."

We note with regret the death of **Chester L. Kingsbury** on June 28, 1974, in Keene, N. H. — **Max Seltzer,** Secretary, 60 Longwood Ave., Brookline, Mass. 02146; **Leonard Levine,** Assistant Secretary, 519 Washington St., Brookline, Mass. 02146

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Morton A. Smith writes from 21 Brainard Ave., Great Barrington, Mass., "My wife passed away last September. She had needed my care 24 hours a day for the past 13 years. Am still doing some radio service work at home." . . . **Arthur R. Ford** writes from Ridley Park, Penn., "Retired December 19 after 25 years with the U.S. Naval Air Development Center, Johnsville, Penn., engaged in varied studies pertaining to naval aircraft." . . . **Dean Webster** wrote that he attended his 60th reunion at Andover this year and as Chairman was well engrossed in activities. He writes further, "We had a restful three months in Scottsdale, Ariz., in January, February, and March. Arizona had the poorest, coldest winter in 50 years — Florida its best. We never know. We are presently at our apartment in Boston but will go to our permanent residence in New Hampshire shortly."

The *New York Times,* June 13, 1975, carried the news of the death of our classmate **John Ogden Merrill, Sr.,** at his home in Colorado Springs on June 10, 1975; he retired as a partner in Skidmore, Owings and Merrill in 1958 and was in charge of the design of the U.S. Air Force Academy, and of the nuclear-research installation at Oak Ridge, Tenn. Also he directed the development of the permanent Army and Air Force facilities on Okinawa, and the Fort Hamilton Veterans' Administration Hospital in Brooklyn. He studied architecture at M.I.T. and after working with Granger and Bollenbacker, Chicago Architects, he served as chief architect for midwest states for the Federal Housing Administration in 1939 before becoming a partner in the Skidmore firm in Chicago. He was a fellow of the A.I.A. and a past president of its Chicago chapter. He directed the revision of the Chicago Building code in the late 1940s and was captain with Coast Artillery in World War I. He lived at 101 Gardner Pl., Colorado Springs, Colo. 80906.

Ernst F. D. Von Voss drops us a note saying, "Can no longer write too well but enjoy reading *Tech Review.*" . . . A card from **Nelson Bond** told of his trip up to New Hampshire where he saw Sax Fletcher, '18, and that he is back to Schenectady for the summer.

Ray H. Bartlett passed away on May 20, 1975 after a brief illness in the Holy Cross Hospital of Fort Lauderdale, Fla. His son wrote to say emphysema complicated by artheriosclerosis was the primary cause.

Your secretary is enjoying golf, music and good weather this summer at Chautaqua, N.Y. — **E. R. Smoley,** Secretary, 50 East Rd., Delray Beach, Fla.

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A brief report on our 55th Reunion for those who were unable to make it. In attendance were Betty and **Norrie Abbott,** Theresa and **Larry Allen,** Esther and **Frank Bradley,** Mina and **Perk Bugbee,** Amy and **Harold Bugbee,** Betty and **Al Burke,** Pat and **Buzz Burroughs,** Marie and **Phil Byrne** and their daughter, Katherine, all the way from Hong Kong, Ann and **Bink Carleton, Earren Chaffin,** Barbara and **Bill Dewey,** Lois and **George Des Marais,** Gladys and **Foster Doane,** Evangeline and **Count Dumas,** Paye and **Herb Fales, Al Fraser,** Billie and **Dick Gee,** Marjorie and **Henry Hills, Frank Hunt,** Hannah and **Harry Kahn,** Helen and **Morris Lipp,** Kay and **Frank Maconi, Jack Nolan, Stan Reynolds,** Kay and **Bob Sjostrom,** Lois and **Harold Smiddy,** Florence

and **Lee Thomas,** Eleanor and **Bob Tirrell,** Ruth and **El Wason, Al Wason,** and **George Wilson.** A goodly turnout and all appeared to have a good time. We started off with the Pops concert at Symphony Hall where some of us had the unusual experience of sitting virtually underneath the orchestra, which we knew was there by the glorious sounds that rolled over our heads and by the tips of the cello bows darting in and out. Then, after a cool, restful night at McCormick Hall on campus, we enjoyed Alumni Day with its brilliant display of faculty erudition, a fancy box lunch and a fine cocktail party, dinner at the Student Center and a return to the dorm to rest up. Our final day started off with a hearty "brunch," then we bussed to the M.I.T. Historical Collection Center which held us enthralled for an hour or more. It took two good-sized busses to transport us to Long Wharf for a cruise of Boston Harbor on the good ship "Holiday," where we had a chance to inspect the veteran flagship of the Hudson River Day Line, "Peter Stuyvesant." Our class banquet, with cuisine by Pier 4, the famous harborside restaurant, was held on her third deck. With Norrie as master of ceremonies and Liz and Jim Killian as guests of honor, our Class Agent, Perk Bugbee, announced a record participation in the Alumni Fund of 50 per cent of the class, higher than any other class for '75. Dr. Killian expressed admiration and affection for the good old Class of '20 in his usual eloquent fashion. The secretary read excerpts from letters from: Vera **Howes,** widow of **Homer,** who accompanied her letter with a generous contribution to the Fund in honor of 55th; Ilsa **Reed** who told of the plans of her husband, **Chuck,** who had hoped to be with us but whose terminal illness just previous to reunion prevented it; from **George Morgan, Jim Scott, Heinie Haskell, Herb Fairbanks, Jim Gibson, Sam Schenberg, Irv Wilson, Tony Anable, Ming Pai, Joe Margolis, Bob Aborn, Dave Kaplan, Art Merriman** and **Skeetz Brown,** all of whom expressed keen regret at not being with us. Prizes in the shape of choice bottles of Amontillado sherry were awarded to the Killians, to the "reunion committee," to Bink Carleton for flying from Amsterdam in time to join us, and to the Frank Bradleys for having the most grandchildren (14) and great-grandchildren (5). Before breaking up the gathering sang "Happy Birthday" to Eleanor Tirrell who certainly picked an auspicious occasion to celebrate the day.

After the reunion, Betty and Norrie Abbott left almost immediately for a tour of Great Britain and Belgium; Gladys and Foster Doane drove from Cambridge to Quebec before returning to Wisconsin; Kay and Frank Maconi also drove to Quebec City before returning to their home in Leominster where Frank is busy organizing a Rotary fellowship for Rotarians having a common interest in antiques. Lois Des Marais, as promised at the reunion, looked up Mary Ross, widow of **Mott Ross** of Basking Ridge, N.J., but found she had moved to California.

Joe Margolis of Hollywood, Fla., writes that he sees **Frank Badger** at the local Rotary meetings. Joe's two daughters live in New York, one the wife of the Director of Neurosurgery at St. Vincent's Hospital, the other the wife of the Dean of Architecture at Columbia University.

On the front cover of the "Islander," a

Heinie Haskell, '20, fronts Islander *magazine*

magazine of Hilton Head Island in South Carolina, appears a very fine and striking portrait painting of our own **Heinie Haskell** shown skippering his "Morgan 34" sailing yacht. Cap'n Haskell was one of the pioneers of sailing on this distinguished resort and has sailed single-handed around the distant Texas Tower. More power to him!

Marie and Phil Byrne celebrated their 50th wedding anniversary this year, and Esther and Frank Bradley celebrated their 50th a couple of years ago. We congratulate these stalwarts of the Class! . . . **Jim Scott** writes that he has two grandchildren studying in New England, one at Dartmouth, one at Putney, Vt. He also has one in Philadelphia and no less than *seven* in Virginia where Jim resides in Richmond. . . . **Roger McNear** writes that he is still living on the desert in Tucson, Ariz., where he moved from Duxbury for reasons of health. . . . **Harold Bibber** writes, "since being remarried in 1973, we have traveled to Australia and New Zealand, spent part of the summer in Upper Michigan and last winter at Sanibel Island, Fla." Their home is in Columbus, Ohio. . . . **Herman Marrow** writes that he is doing volunteer work at the Sarasota Memorial Hospital. When not otherwise occupied, he plays golf.

Fred Hopkinson died on June 2. Formerly of Rochester, N.Y., his home since retirement was at 409 Riverside Dr., Cocoa, Fla. — **Harold Bugbee,** Secretary, 21 Everell Rd., Winchester, Mass. 01890

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Class President **Irving Jakobson** sent me a welcome report of Alumni Day in June. Attending from our Class were Maida and **Ed Dubé,** Eleanor and **Don Morse, Royal Wood, George Chutter, Bob Miller** and Jake. Reunion Chairman Ed Dubé held a meeting after lunch to discuss 55th Reunion plans and the following schedule resulted: arrive at Wentworth-by-the-Sea, Portsmouth, N.H., Tuesday afternoon, June 1, 1976; spend Wednesday, June 2, sightseeing or loafing, with a clambake for the evening repast; depart after lunch Thursday for Cambridge with accommodations at McCormick Hall; Boston Pops that evening and Alumni Day events Friday June 4; disband Friday evening or Saturday morning as desired. Note the dates and plan to attend. **John Mattson** has been appointed as a member of the reunion committee to help with the planning.

A newsy letter arrived from Assistant Secretary **Josh Crosby,** just too late to get in the July/August Class Notes. Wrote Josh: "The day you and Betty left Sarasota the **Royal Woods** arrived to spend the month of March. Woodie, **Whit Spaulding,** and I renewed golf matches and we had a good group from 1921 at the M.I.T. Club's ladies' night dinner meeting in March as well as the club picnic in April on Casey Key. Attending one or both affairs were Katherine and **Larcom Randall,** Winn and **Royal Wood,** Beth and **Whittier Spaulding,** Helga and **Jim Parsons,** Millie and **Herb Kaufmann,** Bea and **Tom Dutton,** Edna and **Phil Coffin** and the **Crosbys. Garvin Bawden** and **Dick Windisch** sent regrets. **Whit Spaulding** was elected a Director of the M.I.T. Club for a three-year term and was chairman of the picnic committee." The Spauldings and Crosbys spent the summer in Maine.

A news release from the University of Hartford announced the selection of **John G. Lee** as one of 11 Connecticut citizens who were made honorary members of the Board of Regents. He was the first Chairman of the Board of Regents from 1957-65. After graduating from Course II with a master's degree, John taught aeronautics for a year at M.I.T., held various aeronautical posts in industry and retired as Director of Research at the United Aircraft Corp. In the 1940s he joined the Board of Trustees at Hillyer College and was instrumental in negotiations which led Hartford Art School, Hartt College of Music and Hillyer College to form the University of Hartford. John and his wife have four children and several grandchildren.

A letter from **Bob Miller** enclosed a clipping from the *Cape Cod Standard Times* telling of a head-on collision between two cars, one driven by **Bob Haskel.** He and Laura were taken briefly to Cape Cod Hospital but are doing all right. Answering my inquiry of concern, Bob Haskel wrote: "Both cars were total losses. The other car swerved suddenly right into us and the driver said he never saw us. Laura and I had on both seat and shoulder belts and these saved our lives. We still have aches and pains but expect to recover. When we later saw our car we wondered how anyone came out alive."

A change of address came from **Bob Worsencroft** who writes: "Our hopes of moving from Wisconsin to Sun City didn't materialize last fall. My wife came down with arthritis and couldn't travel. Our house was sold and we moved into an apartment at 6302 Mineral Point Road, Madison, Wisc. 53705. She has since recovered and we are going to try again this fall. I hope it takes, as I am fed up with our winters and apartment living. I spent some 45 years at the University of Wisconsin before I retired as Professor of Engineering Graphics. I met **Jack Rule** many times at A.S.E.E. meetings. During my time at the university, I engaged in many outside activities ranging from structural design to drafting work for the state Highway Dept. I also was a co-author of several textbooks. My wife and I have been married 48 years, have two children — a

son and a daughter, he a senior underwriter in Los Angeles and she an M.D. in Milwaukee. My hobby is furniture construction. This past winter was the first in years we missed going to Phoenix and Sun City where we have many friends. I'll write again if we make it." Many thanks, Bob, for your letter.

Wallace Adams of Middletown, Ohio, was hospitalized the first half of August for removal of his gall bladder. He wrote from the hospital just before the operation and again ten days later. The surgery was successful but a black-out caused by a blood clot extended his hospital stay for ten days. Said he: "Recovery should be perfect." In his first letter, Wally wrote that their Western Parks trip was all he and Anne expected it to be. "Good weather, congenial party, well conducted. Schedules arranged to arrive at each point at the best time of day. Covered 1800 miles by bus between Salt Lake City and Santa Fe — just no railroads through that part of the country." Wally is now busy setting up plans for a Boy Scout Jamboree in June 1976 — five Scout Councils involved, and ten to 12,000 boys. "I think our big problem will be "Johns", as the ground water table is high."

An Alumni Fund envelope furnished news that Genevieve and **Williston Wirt** would spend two weeks during the summer exploring the canals of England in a canal boat. Will wrote in a subsequent letter that they read about the canals in the National Geographic and found a travel bureau in Palo Alto that makes a business of canal trips. They signed up for a week in a London hotel canal boat." They went from Worcester to Birmingham to Stratford on Avon where they saw "Henry V" at the Shakespeare theatre. "Good weather, so the trip was fine, food excellent and the boat tied up for lunch, morning and afternoon tea, and dinner at 8." Reported Will further, "Things are still good here. Pilgrim Place is as nice a retirement colony for old worn out parsons as there is anywhere." Incidentally, his address has changed to 694 Avery Road, Claremont, Calif. 91711.

Your Secretary's summer activities have involved contacts with several classmates. In late June, I was on Cape Cod for a family wedding and dropped in to see Marion and **George Chutter** at their home in East Dennis. Their flower and vegetable gardens were doing well and George was busy building a rock retaining wall. They were hoping to take a trip to Vermont later on to visit friends and relatives. . . . In late July, Betty and I drove to New Hampshire and spent three weeks at Squam Lake. We drove down for a picnic lunch one day at Katherine and **Larc Randall**'s place on Lake Winnipesaukee. After a drink and lunch, Larc took me out in his high-speed power boat and we pounded the waves for a cruise among the islands. A pleasant day in a beautiful spot with good friends! . . . Helen St. Laurent wrote from Center Lovell, Maine, that she hoped Betty and I would visit her at Vinalhaven if we got up to New Hampshire. We didn't make it but it was a kind and cordial invitation. She also mentioned she hoped to see Graciela and **Helier Rodriguez** this summer as they had plans to drive North. Helen attended a Bicentennial church service one Sunday in Center Lovell and found Theona and **Al Genaske** in the congregation. . . . A phone call to **Chick Kurth** in Wolfeboro, N.H., brought forth the news that he and Laurie were doing well, all things considered, and hoped to attend the 55th Reunion next year.

It is my sad duty to report the deaths of five classmates this month: **Lemuel Pope** of Washington, D.C., on March 31, 1975; **Edwin F. Delaney** of Naples, Fla., on June 12, 1975; **Algot J. Johnson** of Gloucester, Mass., on May 26, 1975; **John J. Healy** of Scituate, Mass., on June 6, 1975; and **Victor S. Phaneuf** of Largo, Fla., on July 16, 1975. Both **Ed Delany** and **Vic Phaneuf** were at luncheons I attended in Florida last February and added to the good fellowship of the occasion. Ed Delany was a veteran of World Wars I and II and retired from the Air Force Reserve as a lieutenant colonel in 1965. He was a partner in the firm of Hedge and Mattheis Road Equipment Co. of Needham, Mass. **Phil Payson** reports that Ed died in his sleep from a heart attack. Phil attended the funeral mass and also visited Ed's wife Kathryn who was in the Naples Community Hospital. . . . **Algot Johnson** worked for the New England Telephone and Telegraph Co. for many years, retiring as Traffic Supervisor. . . . **John Healy** graduated from Harvard in 1919 with an A.B. in chemistry and from M.I.T. with an S.B. in chemical engineering in 1921. He worked for Monsanto in several executive positions until retirement in 1964. In 1968 he joined Moleculon Research Corp. as Vice President in charge of chemistry and physics. He was past President of the American Institute of Chemical Engineers. . . . **Victor Phaneuf** was a veteran of World War II and for many years was a professor in the Building and Construction Dept., University of Florida. **Elmer Campbell** wrote that he, **Allen Addicks** and **Helier Rodriguez** attended the funeral mass and acted as pallbearers. The sympathy of the class is extended to the families of these men. — **Sumner Hayward,** Secretary, 224 Richards Rd., Ridgewood, N.J. 07450; **Josiah Crosby,** Assistant Secretary, 3310 Sheffield Cir., Sarasota, Fla. 33580; **Samuel E. Lunden,** Assistant Secretary, Lunden and Johnson, 453 South Spring St., Los Angeles, Calif. 90013

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Here's hoping that all classmates have had a lovely summer with tennis and golf and just sitting looking at beautiful scenery, or perhaps traveling or visiting families and friends. Buffalo and the shores of Lake Erie have been particularly good to us this year, and we are high on everything including golf scores. Our summer trips have only included the Canadian Stratford for Shakespeare Plays and Lewiston's Artpark to see the Bolshoi Ballet beautifully staged along the Niagara River near Lake Ontario. . . . **C. Randolph Myer, Jr.,** President and General Manager of Souhyem Wood Products in Wilton, N.H., tells us he has been active in tennis, skiing and gardening this summer. That is the advantage of living near the mountains in one of the most beautiful areas of our country. . . . **Wyatt H. Ingram** has been spending most of the year on Fire Island, bird watching and writing a book on electrical networks. . . **Donald F. Carpenter** has written from West Chop, Martha's Vineyard where he has spent the summer for many years. We hope his tennis is as proficient as usual. . . . **John L. Vaupel,** Barters Island, Boothbay, Maine, has sent a beautiful picture of the lobster pots and buoys along their coast. He has enjoyed the New England area with the availability of golf, tennis, swimming and a good view of the Atlantic. John enjoys his "7-room home, 100 feet from the tidal water, where he can moor a sail boat and tuck away a canoe" for total quietude. John and Maria recently took a cargo boat to Antwerp and then drove to Brussels and on through Cologne to Hanover. Then they went through the Brenner Pass to Lake Garda in Italy where Maria had distant relatives near Bologna. John is serving on the Planning Board at Boothbay, working out Environmental Rules for the Mid Coast Regional Planning Commission. He also spends time as a trustee for the Boothbay Region High School. When the area gets cold they visit Maria's family in Virginia for the Christmas holidays. John's last bit of praise for the Maine area as he sails around or paddles his canoe in and out of the inlets is that the mackerel bite on bare hooks. It sounds like the Good Life.

We have received a postcard of the Columbia Glacier from the **Dale Spoors** telling of their Alaska travels and visits through the West Coast area of Laguna and San Diego. On the way down they had a pleasant lunch and visit with Catherine and **Mac McCurdy** in Seattle. They continue to live up to the name — "The Traveling Spoors."

Madeline and **Parke Appel** have written of their enjoyable travels having now returned to Florida from their visiting and Alumni Day trip to Massachusetts. Parke attended his 58th Reunion of the Somerville High School Class. He also presented Red Coats to Chancellor Paul Gray and Class Professor Arthur Mattuck for Pops and Commencement. He reports that registered for attendance at Alumni Day were Ruth and **Yard Chittick,** Catherine and **George Dandrow, Lawrence Gentleman,** Mary and **Oscar Horovitz, Marjorie Pierce** and **Fearing Pratt.** During their visit Madeline and Parke drove up to Whitefield, N.H., to survey the Spalding Inn Club and visited with Anne and **Randall Spalding.** They tell of ideal conditions with golf, tennis, putting, swimming pool, bowling greens and excellent rooms and dining facilities. They suggest the week ending June 11, 1977 after Alumni Days as our date for the 55th. They also were entertained with dinner and a special film show by Oscar and Mary Horovitz. Parke reports he visited with Julius Stratton and received an excellent copy of the original Tau Beta Pi Charter granted to M.I.T. listing the names of those selected from 1922 and 1923 classes. On request Parke will send a copy to any of those listed. Oscar Horovitz has suggested we deposit our class film treasure for safe keeping in the archives at M.I.T. We have a large accumulation of documentaries. On their return trip to Florida, Parke and Madeline visited Louise and **Don Carpenter** who took them to view the dioramic exhibits of the discovery and exploration of America, the spectacular work of **Ernest N. May** of Wilmington, who has devoted years of effort and fortune to its realization. Parke is spending the summer planning his meetings of the local chapter of the Telephone Pioneers of America, of which he is vice president. He is also planning a drive for funds for the Episcopal Church and the M.I.T. Club of Southwest Florida. He is the official pho-

tographer of the Sarasota Shrine Club and sings tenor in the church choir. We all in unison say, "I don't know how he does it."

These items are written as notes for conversation as we get together in the near future for our 55th as "The strongest memory is weaker than the palest ink." Best wishes for good health. — **Whitworth Ferguson,** Secretary, 333 Ellicott St., Buffalo, N.Y. 14203; **Oscar Horovitz,** 3001 South Course Dr., Pompano Beach, Fla. 33060

23

Two items of news from **Arthur R. Belyea** of Old Saybrook, Conn. The first concerns himself. On a volunteer basis for the Old Saybrook Historical Society, he is transcribing the 19th-century papers and letters of Capt. Ambrose Whittlesey describing life in that town in the 1820s. Art describes the operation as quite difficult due to the fragility of the papers coupled with the illegibility of the handwriting. Among the letters transcribed was a description of a 144-day voyage around Cape Horn, including problems with mutinous men. The other matter concerns good old **James A. (Pete) Pennypacker** and his cello and cello playing. Pete, who has had a long, distinguished career in marine architecture, has studied with professional musicians, written a book *Cello in Church,* and played with the Quincy (Mass.) Symphony Orchestra; now he is struggling to restore his skills on the cello after a stroke six years ago. A *Christian Science Monitor* clipping concerning the Western Pacific Railway and its Chairman, our old friend and classmate **Alfred E. Perlman,** records that railroad's success competing with the much stronger and longer Southern Pacific by establishing industrial parks along its right of way, thus gaining important traffic.

Miles N. Clair, President of the Thompson and Lichtner Co., Inc., of Brookline, Mass., has been elected Honorary Member of the American Concrete Institute by its Board of Directors in recognition of his "extraordinarily meritorious service in pioneering the development, use, and control of concrete as a construction material." Miles received his B.S. degree from Drexel University in 1921, and he returned there in 1960 for an honorary degree of Doctor of Engineering.

Thomas E. Rounds, his wife Marjorie, and granddaughter Michelle have reported on a week's trip through northern New England, including stops at the Shelburne Museum, Vt.; Lost River, in N.H. (where Tom guided in 1922); the Maine Coast (Ogunquit, where "we gorged on clams and lobster"); and then southern Massachusetts and home.

And now for some bits and pieces — **Lothrop H. (Duke) Bailey,** '25, wishes "all my former classmates of 1923 and (1925) a happy and glorious bicentennial year." **Dale S. Davis** summarizes his career this way: "1923 B.S. in Course X; 1924, S.M. in Course X-A. Married Marguerite Stevens in 1927. Industrial work and teaching. Eight books in nomography and empirical equations. . . . Instructor in chemical Engineering, Wayne University, 1937-42; Professor of Chemical Engineering, V.P.I., 1948-56; Professor and Head of the Department of Pulp and Paper Technology, University of Alabama, 1956-66; since then Professor Emeritus. New address P.O. Box 6, Bailey Island, Maine, 04003." **Orr N. Stewart** reports that retail sales "picked up rapidly in the last month." He hopes to come to Boston for the '76 bicentennial.

Belatedly we learn of the passing of **Gabriel J. Lund** of Larvick, Norway, on December 31, 1973. Also we hear that **Charles G. Ball** died in July of this year (1975). Lund was a native of Norway and graduated with us in electrochemical engineering. His life was largely spent in Norway in the Judiciary and various advanced positions as chief of police of cities and districts. During World War II he served with the Norwegian Legation in Stockholm, later joining the David L. Babson Co. to become its Vice President, Director, and Clerk of Corporation. — **Thomas E. Rounds,** Secretary-Treasurer, 990A Heritage Village, Southbury, Conn. 06488

24

It is late in July, the temperature 89° (32° Celsius), the Dew Point 70° and your Secretary is trying to project himself into "October's bright blue weather." This launching is further complicated by lack of news from all sources and an uneventful Alumni Day. Of course, last year's 50th set a high standard, but those of us who attended on June 6 were disappointed in the brevity of the occasion and two of us very much misled by the title of one of the seminars. Austerity may have dictated the day's format, but your writer would hesitate to travel further than Brookline to attend a similar program.

J. Earl Frazier, President of Frazier-Simplex, Inc. of Washington, Penn., has been elected President of the Advisory Board of Trustees, Department of Ceramic Engineering, University of Illinois at Champaign-Urbana. He was awarded a B.S. degree at Washington and Jefferson in 1922 and earned his Sc.D. in Chemical Engineering with us. He joined Simplex Engineering in 1926 and has been Director of the Washington Union Trust Co. and several organizations. He is a member of Phi Beta Kappa, two other fraternities and many associates in Brazil, England and the United States, indicating a broad interest in ceramics, chemistry, photography, art and civic projects.

A letter of June 14 from **Clint Conway** to **Herb Stewart** adds information on the Third Florida Fiesta. Clint regrets the absence of Herb and Winnie, believing that they would have reported fully and that possibly Etienne and **Gene Quirin** might have contacted your secretary as a neighbor. The Fiesta was a two-day affair, most of the participants staying at the Bay Harbor Inn on the Tampa side of the new Campbell Causeway to Clearwater. There were 34 classmates and wives, not 15 as previously stated. It opened with cocktails and a "no speeches" dinner at the Green Heron Restaurant at Bay Harbor on Friday, February 28. Most men wore their 50-year Class jackets. Sara Roig was ill and **Luis Ferre** had to cancel. **Henry Tanck** had dinner with Clint early in April in Clearwater. He has been with the Navy Department since retiring from R.C.A. Communications, Inc., so there was much to discuss on the happenings during 50 years.

Paul Cardinal, on June 25, reported Lorene laid low by a 105°F temperature; anticipated recovery to normal strength in two weeks. Fortunately, daughter Carolyn surprisingly arrived from Houston to take over the home recuperation for five days. Paul had a card from **Cy Duevel** reporting a heart attack about May 19, sending him to intensive care for 16 days. With effective medication things are under control, and plans are being made for our 55th. . . . Peg and **Pret Littlefield** were to fly to Norway on June 24, but we have had no word of fait accompli or return. . . . A note from **Luis Ferre** to your scribe expressed appreciation for a '24 Class cap sent to him, but did not mention the pewter mug of our 45th. That was the last one in our inventory. . . . Edith and **George Knight** returned in May from the Winter in England. At this writing, they are heading back East from Arizona, California, Oregon, South Dakota and way stations, camping en route. They should be in Hingham, Mass., again on the seashore about August 10.

Your class officers in New England seem to be content, and not to wander afar. **Frank Shaw** and **Herb Stewart,** separately, will spend a week in Maine. **Ed Moll** vacillates between Bath, Maine, and Scituate, Mass., and **Russ Ambach** sits beside the pool at his condominium. **Ray Lehrer** spends long weekends at his lakeshore Pickwick Lodge in West Newfield, Maine, but will see red in October when he flies to Moscow and Leningrad for nine days with the Shriners.

We extend our sympathy to Hortensia and **Mike Amezaga** on the sudden loss in July of son-in-law, Rafael Talavara in Washington, D.C., husband of daughter, Julio. He was the victim of an attack of meningitis. — **Russell W. Ambach,** Secretary, 216 St. Paul St., Brookline, Mass. 02146; **Herbert R. Stewart,** co-Secretary, 8 Pilgrim Rd., Waban, Mass. 02168

25

The Reunion is now past history, but we can always hope that history repeats itself in 1980 with one just as filled with things to do, old friends to meet, and as good a time to be enjoyed by all.

The first and most important news is that of our Reunion Gift. Thanks to **Garvin (Chink) Drew,** the Gift Chairman, many other helpers and most of all you who contributed, we equalled the goal that we had established for ourselves plus a little extra, the total being $508,000.

At the business meeting the following officers were elected for the next five years: Chink Drew, President; **Ed Kussmaul,** Vice President; **Doc Foster,** Secretary; and **Willard Gardiner,** Treasurer. **Jim Howard** was later appointed Class Agent.

Now for some of the Reunion highlights. Including wives and guests there were about 145 in attendance at part or all of the event. Wednesday was registration day at McCormick Hall, where we were bedded down. Baseball caps were distributed to the men, sun hats to the ladies. Plastic raincoats to everybody (and they were needed on one rainy morning). The souvenirs were attractive bowls with an appropriate engraving. Thursday morning we visited the Historical Collections, well worth seeing; in the afternoon a Japanese Tea Ceremony, then the class picture followed by a cocktail party and a hot buffet dinner before "Tech Night at the Pops." After the events of Alumni Day (Friday) we were honored by a reception for our class in the President's House followed

Singing and absorbed eaters from the 50-year celebration of the Class of 1925

by the Class Dinner at the Faculty Club; and after dinner **Milt Salzman** introduced his Barbershop Quartet made up of class members who lead in quartet and group singing. Saturday morning was free, followed by a boat trip to George's Island for a clam bake; the evening featured entertainment of various kinds. And Sunday was "the end." I am sure that if a vote were taken the opinion would have been unanimous: "A grand time was had by all" thanks to Jim Howard, Ed Kussmaul, and many other helpers.

Edward Zetterberg and his wife attended Commencement to witness the graduation of their grandson, but they were not able to attend the Reunion. **John Campbell** had to leave early to receive an award: the Horace H. Rackham Humanitarian Award given by the Engineering Society of Detroit.

As you have been made aware, this is the last time I shall sign these notes, which I've enjoyed writing. — **E. Willard Gardiner,** 53 Foster Street, Cambridge, Mass. 02138. Send future news to **F. Leroy Foster,** Box 331, Chatham, Mass. 02650

26

One classmate, **Ben Richardson,** is already counting the months to our 50th Reunion and by the time you read this those months will be down to about six. Ben still pursues the study of genealogy with vigor, and with two daughters, seven grandchildren and two great-grandsons he keeps adding new branches to the family tree. . . . **George Makaroff** has selected a more rugged endeavor, he says upon advice of his M.D., he climbs mountains and enclosed a colored shot (rear view!) sitting on a log beside a birch tree looking out over Giant Mountain in the Adirondacks. . . . Another outdoorsman, **Whit Ashbridge,** continues his worldwide passion for hunting and his photos are from Southwest Africa and show his "record book" kudu which won him a medal in the Windlock Trophy Show last September. Whit has another new chevron too — a third grandson named after him! . . . **Stewart Perry** continues his high-level interest in ham radio among many other hobbies, but having been involved since 1932 he is really dedicated and writes a six-page bulletin (single spaced!) three times a year. In a recent letter Stew mentioned that he planned to visit our "perpetual calendar" classmate **Bill Edwards** in Hawaii and then return for a summer at his farm in Maine on the Harrington River. . . . A letter from **Ed Huckman** reports, "The highlight of our spring was attending a concert of the 90-piece M.I.T. Symphony Orchestra at Storrs, Conn. An excellent performance and a fine group of young people. We went with the **Eliot Bidwells** and enjoyed reminiscing about the Class of '26. See you at the 50th Reunion."

A few "back of the envelope" notes include **Ed Hope:** "Still with the U.S. Office of Education trying to help Developing Institutions. Hope to be at the 50th but this time without my wife, Marion, who passed away last August. Saw **Clifton McFarland** here a few weeks ago." . . . From **Arthur Fuller**: "I'm still enjoying San Diego's mild weather in contrast to the gales off the stern, New England coast." . . . From **Karl French**: "Although my permanent residence is in California, I am presently in Virginia, as a consultant to Allied Chemical Corp., Fibers Division. See **S. B. Besse** now and then when I get to Newport News. Hope to attend the 50th reunion — my last was the 35th." . . . Finally, from **Bill Loumas:** "I have retired from the post of District Architect-Engineer of the Austin Co., 450 West 1st Ave., Roselle, N.J."

This cross-section indicates the diverse interests of the class of '26 in retirement. We have yet to run across a thumb-twiddler, but there's nothing wrong about that either. Sailing has taken more of our summer this year because for the first time we have a crew who will join us for a practice run whenever there is enough wind to fill a spinnaker. At the moment we are readying the boat to trail it to Buzzards Bay for the National Championship this coming week, after completing one more local race off Pigeon Cove this terribly hot Sunday afternoon. Yes, on occasion it does heat up even at Pigeon Cove and this occasion has lasted about a week. A quick dip in the cold Atlantic changes things rapidly however and although it has been many years since we have braved these icy waters, this turned out to be the year.

Now for the ticking clock. This month it continues its toll. A letter from Barbara **Larratt** tells of **Ted**'s death on June 7 at South Paris, Maine, after being flown "home" in May via ambulance plane from their home in Winter Park, Fla. Ted was 71, like most of us and had spent his career in aircraft design starting with Curtis Wright in 1928 with service at United Aircraft, Glenn L. Martin, Canadair, and at retirement, Kaman Aerospace. Barbara tells me that Ted had planned to visit Pigeon Cove and carried a note in his pocket with our address — and — I had planned to visit him at South Paris when learning recently that he was there summers. . . . Even more recently the ticking clock has brought a hurried memo from classmate **W. H. Hoar** to which was attached a clipping from the Washington Star telling of the death on July 24 of **Alton S. Heyser.** Bill Hoar writes: "**Bob Franklin** and I both saw Al a few days before he died."

I'm sure we have mentioned the memorial service for M.I.T. alumni held in the beautiful chapel each alumni day. The chapel is a part of the Kresge complex but stands by itself and I always attend the service knowing that many of you cannot get to it. This year there were 17 of our classmates on the roster of those whose deaths were reported for the past year. It is a moving service and this year's service was conducted by Robert L. Meier, '44, a Congregational minister. The chapel is designed to accommodate any belief and I find it comforting to drop in for a few moments of meditation when in the area.

There have been a few references to our up-coming 50th reunion, but from here on in the Class Notes will be basically devoted to the big event. We will welcome notes or inquiries from anyone having questions about the reunion. If we cannot answer you **Don Cunningham** will, but for now our principal concern is getting the boat ready for Buzzards Bay and upon signing off we will take the trailer over to the yacht club to prepare for the haul out. It seems incongruous, but anyway "Happy Thanksgiving" and Cherrio! — **George Warren Smith,** Secretary, P.O. Box 506, Pigeon Cove, Mass. 01966

27

Sadly, I must report that **Bill Taggart** died on June 19, at his home in Belmont, Mass. It was a double shock, because the last I had heard of Bill — from **Ray Hibbert,** early this year — was that he was making great progress in recovering from the stroke he suffered early in 1974.

Bill was one of those too-rare people who can always find time in a busy life to serve others. He was a vice president of our class, and in charge of Class Estates. He served on the M.I.T. Alumni Council, and in 1962-63 was the 69th president of the Alumni Association. He had been a member of the M.I.T. Corporation and of the Wentworth Institute Corporation. He was also on the boards of directors of Massachusetts Blue Cross and the Cambridge Trust Co. His business career was spent entirely with Dewey & Almy Chemical, now a part of W. R. Grace & Co. He became president of Dewey & Almy in 1962, and in 1966 was appointed executive vice president of the Grace Industrial Chemicals Group. He retired in 1969. Bill is survived by his wife Eileen (Altree), a son, two daughters, and eleven grandchildren. . . . One more unhappy note: **Frank Meyer** writes me that his beloved wife Winifred — whom many of us remember from the 40th and 45th reunions at Bald Peak — passed away on June 13, at Peoria.

Kenneth Vint has retired and is living in Boxford, Mass., after spending the past ten years teaching chemistry at a local junior college. Before that, he had worked for duPont and G.E. around the country, mostly in production, and had been involved in atomic energy work. Like so many of us, Ken says he is worried about when — or whether — the country is going to stop inflation. . . . **Leonard Riley** is working, with colleagues, on a book on assaying, for the U.S. Geologic Survey. Since his retirement from the Survey last February, he has con-

tinued to serve it on a part-time basis. . . . **Emory Patterson** has left Brunswick, Maine, for Green Valley, Ariz., in what he designates as their last move. He will have a classmate as a neighbor. . . . **Charley Smith** will be spending the months from November through May at 1231 Carmino del Sol, Green Valley. From June through October he will return to the Cincinnati area, in Monroe, Ohio. . . . **Frederick Bodden** writes belatedly of his wide-ranging activities last year: "Visited relatives in Nuremberg, Germany; toured by car through Bavaria, Austria, up into the Alps, with side trips to East and West Berlin and into Italy; and after six weeks came home tired. Then followed five weeks in Wisconsin by car. Came home to rest, but our little family all met at Lake George for a two-week get-together with lots of rest, boating, attending the Sailing International Competition. A great year! A recent coronary flare-up has not required any curtailment of my activities."

As these notes are written, at the beginning of August, your secretary is acting temporarily as Director of Finance of New Rochelle, following the resignation of the Director. The City is trying to recruit a permanent Director, so that I can step back to the somewhat more comfortable job of City Treasurer for the one year I have to go before compulsory retirement. Meanwhile, it's going to be a demanding summer; the department was already undermanned due to a job freeze before we lost the Director. — **Joseph H. Melhado,** Secretary, 24 Rodney Rd., Scarsdale, N.Y. 10583

28

The Alumni Day Centennial Celebration exercises in June were well attended by '28ers. As usual, the Pops Concert was superb and played to a hall completely filled with enthusiastic M.I.T. alumni. The various seminars and addresses were instructive and inspiring and meetings with classmates most enjoyable. We strongly recommend to all of you these annual occasions which, though brief, are always lively and rewarding. We have been told that the total audience this year was the largest ever.

We have a most welcome note from **John Carvalho** who writes: "I retired in 1963 as principal of one of the larger grammar schools in Fall River, Mass., after having been a mathematics teacher in the High School for 14 years. My wife and I then started traveling. We saw a large part of this country then took a cross-Canada trip and a long Western European trip. We also visited the Orient and Hawaiian Islands. While in Tokyo we spent a friendly evening with **Shikao Ikehara.** We were in Cambodia in October, 1969, unaware of how soon dire things would be happening right behind us. We were impressed with the beauty of Phnom Penh and wonder what it looks like now. We had to stop most of our traveling after this last trip because I had a heart attack in 1970. We still go to Florida for five months each year to escape the cold New England weather. My present poor health has prevented my attendance at recent reunions."

We are very sorry to learn from **Francis Sweeney** that Edith, his wife for almost 48 years, died suddenly in April, 1975. . . . **Frank McGuane** writes that he has five children and five grandchildren. His youngest child was graduated from Stonehill College in May, 1975. . . . In a recent note **Ev Lester** says that he would be happy to receive visitors at their new home in Williamsburg, Va.

It is with deep regret that we must report the deaths of two classmates. **Carl Feldman** died unexpectedly on June 30, 1975 at his home in Sharon, Mass. Several local classmates attended the services and, on behalf of the Class, expressed sympathy to Carl's wife Betty and son Peter. Carl conducted his own business as a consultant in electrical engineering. Those of you who attended the 45-year reunion at Bald Peak will recall that it was Carl who so effectively handled the difficult job of registration and room assignments. . . . **Richard D. Hoak** died on June 22, 1975 in Seminole, Fla. His wife, Perry, wrote that Dick had had a good and fairly healthy life since his stroke in 1966 but became critically ill one week before his death. Dick received his Ph.D. degree from University of Pittsburgh and, beginning in 1940, was a Senior Fellow at Mellon Institute in Pittsburgh, Penn. He was a prolific writer in his special fields relating to industrial water and water pollution control and was widely recognized for his work. Sympathy of the Class has been expressed to Perry. — **Walter J. Smith,** Secretary, 37 Dix St., Winchester, Mass. 01890

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Everett F. Kelley writes, "Thanks for the birthday greetings. I returned home after surgery from Mass. General Hospital on Friday, June 13. While at the hospital, I could almost see, from my room, our class reunion in progress at M.I.T. for which I had signed up in February, not realizing what was to come. Maybe, I'll make it next time. If any of my friends from the class of 1929 should happen to vacation at Cape Cod, my wife Marion and I will welcome a visit. Our address is 75 Fisk St., W. Dennis, Mass." . . . **Edwin H. Perkins** is enjoying his retirement immensely. His chief interests are with the fraternal order of Masons, Eastern Star and U.S. Power Squadron. He has been on the Merrimac River Squadron Bridge for eight years and he is starting work on District 18 Bridge (Essex County) as Administrative Officer. "This work should keep me busy for six years or more," he continues, "I still have my 26-foot sloop to enjoy, but the preparation work goes slower each year. Our 45th Reunion at Chatham Bars Inn was sure fun." . . . **Charles W. Sampson** has retired for the second time after working two days a week for the past four years since his first retirement. . . . **Kenneth G. Russell** writes, "We are off to London to pick up our daughter, Susan at the close of Michigan State University spring term of overseas studies. We will then tour England and Scotland and visit friends in Brussels and Paris. We plan to return home at the end of June."

Philip A. Lamb writes, "Since retirement in 1969 from W. R. Grace and Co., my wife Alma and I are living happily in rural Quakertown, Penn. We have traveled extensively in Europe, Mexico and the U.S. over the past several years and we always enjoy seeing new places. Our daughter, Valerie, is married and has presented us with three wonderful grandchildren who live near enough for us to see them reasonably often." . . . A brief note from **Milton Male** states, "Thanks for your kind thoughts and greetings on my 70th birthday. Our daughter and her family are now living in Madison, Wis., so we can travel northwest during the warm weather, and then visit our son and his family in Florida during the winter months. Best regards to all from Maxine and me." . . . **Hunter Rouse** writes, "Life goes on without much change, other than a gradual slowing up. Living in retirement, the only difference is that my salary is stopped but work continues. I am writing another history — on American Hydraulics this time. For a hobby, I have taken up cutting semi-precious stones. We can't decide whether to keep our headquarters here or move to Arizona. If you could dehumidify Florida weather, we might join you and other '29ers there. Regards to all." . . . **Peter Gnoocheff** says that he is both unemployed and semi-retired. He had been working for Carl Maston F.A.I.A. Architect for about 25 years. Last year business was so bad that he joined the ranks of other unemployed professional workers. "Since I am 68 years old and was retired at 64, I am collecting Social Security and able to live comfortably with some additional income." He continues, "I have been working as much as I possibly can. I hope to resume my profession at work as soon as businss improves."

Murray Brimberg writes, "Your birthday greetings are greatly appreciated and I hope they will continue coming for many years. Our class notes in the *Technology Review* are my favorites and get my first priority to get news of our classmates. My wife Mary and I have been spending more time around Washington area, though we have also done some traveling such as several weeks in Florida and visiting our children in the Chicago area. Our usual travel abroad this summer will be delayed in favor of a sojourn this fall to Israel and Spain. Our daughter Carol (Schulman) has decided to forego pediatric practice for the present and enter a specialty, Pediatric Oncology at N.I.H. Cancer Institute, Bethesda, Md. Daughter Judy (Sherwood) has advised us that she will deliver a paper this month at the N.Y. Conference on Hermatology. She is an instructor at the University of Chicago, School of Medicine." . . . **Clayton F. Jarvis** has retired from government service (G.S.A.) as architect-supervisor of construction of public buildings. Recently he had open heart surgery from which he is slowly recovering.

Larry Hamlin writes, "I have finally hung up my professoring uniform and I am in my first year of retirement of my second career, teaching calculus which I enjoyed with a perfect transition from 100 per cent ail to 100 per cent indolence. We are spending six months in Stratford, Conn., and six months in Stuart, Fla. The only thing that I have discovered from the best of the two worlds of existence is that in golf, quantity and quality do not necessarily go together. Best regards to all classmates and a special one to **Hunter Rouse.**" . . . **Joseph D. Murphy** writes, "My memories of the School of Architecture in the old Rogers Building are the very best. The pleasant work that I do in the field of architecture, and the fine people that I work with are the joys of life that are unequaled in all else." — **Karnig S. Dinjian,** Secretary, 6 Plaice Cove, Hampton, N.H. 03842

30

Our 45th Reunion held at Chatham Bars Inn, Cape Cod, in June was a great success due largely to the hard work and effective planning of our Reunion Chairman **George Wadsworth** and his able committee which comprised **Joe Harrington, Jack Latham** and **Greg Smith.** Some 51 classmates and 42 wives attended, as compared with 72 classmates and 55 wives at the 40th. It seems probable that the mid-week scheduling of the Reunion necessitated by a change in schedule of the alumni events in Cambridge may have had an adverse effect on attendance.

As usual, the first evening (Tuesday, June 3) was devoted to a showing of pictures of prior reunions. The showing of these old films is always a pleasantly nostalgic event, especially for those who have been fortunate enough to be present at most of our quinquennial get-togethers.

On Wednesday the weather was somewhat equivocal and most of us took the scheduled bus ride to points of interest in the Chatham area. However, there were a few hardy representatives of our dwindling group of athletes who elected to pursue their favorite sport. After dinner we assembled in the recreation hall of the Inn for the evening program which started off with a report by President **Greg Smith** on recent developments of interest at the Institute and a reminder that on Alumni Day, 1980, we will be expected to announce a respectable 50-year gift. As most of you know, it is customary for the principal reunion classes to make a substantial gift to the Institute. For example, on Alumni Day 1975 the Class of '25 announced a gift of $508,000.00. While such gifts represent the aggregate of all giving by members of the class over a five-year period, a considerable effort is usually required to put together such an impressive sum, and it is well to get an early start on such a project. Accordingly Greg has appointed a 50-year Gift Committee co-chaired by **Ralph Peters** and **Dick Wilson** and comprising **Joe Harrington, Ed Kingsley, Jack Latham, George Wadsworth** and **Otto Ziegler,** as well as Greg and your secretary. We hope that you will begin to give some serious thought to the matter of cooperating on this project.

The rapidly elected class officers for the next five years were **Ralph Peters,** President, and **Otto Ziegler,** Class Agent, with **Ed Kingsley** and yours truly continuing as Treasurer and Secretary, respectively. Thereafter we turned our attention to the principal speaker of the evening, Dr. Harold Edgerton, who was also the speaker at our 30th Reunion in 1960. Dr. Edgerton is, of course, widely known for his ultra high-speed photography and 15 years ago he showed us a number of his more striking pictures. Since that time he has become interested in locating sunken vessels and his talk at the 45th was on this subject. One of his more interesting failures involved an effort to find a 4th Century B.C. Spartan warship using Pausanias' account of its sinking as a source of his information. Perhaps his most spectacular success was the finding, earlier this year, of the Civil War ironclad, the *Monitor,* which sank while under tow off Cape Hatteras. Some of you may have read the extensive article in *National Geographic* reporting this "find." As an incident of his activities in this field, Dr. Edgerton has developed a "side-arm" sonar which apparently is quite helpful in making such submarine searches.

After Dr. Edgerton's talk, **Joe Harrington** summarized the information obtained from the questionnaire that we had filled out upon arrival and the statistical extremes were duly noted as follows: largest number of children (seven) — Margaret and **Joe Scheuren;** largest number of grandchildren (12) — Helen and **Hank Bates;** most children with an M.I.T. degree (four) — Ruth and **Jack Latham;** longest trip to the Reunion shared by Blanche and **Jean Kresser** (San Francisco) and Adelaide and **Doug MacDonald** (Europe); and shortest trip to the Reunion — Jo and **Dick Foster** (Chatham, Mass.).

By Thursday noon the weather had sufficiently improved to permit the traditional clambake to be held out-of-doors. The Chatham Bars Inn has a special rather elaborate clambake area and impressively competent people to operate it. The products they produced were delicious, although one classmate, who shall be nameless, chose a frankfurter instead of lobster. Afterwards, many of us proceeded to Cambridge for M.I.T. night at the Pops and the Alumni activities on Friday, both of which were extensively reported in the July issue of the *Review.* Classmates who attended the events in Cambridge but did not get down to the Cape included our former Assistant Secretary **Louise Hall** who is now retired, as well as **Bob McCarron, George Schrigley** and **Bill Selden.**

The 45th was great fun. We hope you will start making plans now to be present at the 50th — **Gordon K. Lister,** Secretary, 530 Fifth Avenue, New York , N. Y. 10036

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To cap off Alumni Day, the **Larry Barnards** and the **Claude Machens** organized a get-together for the Machens' backyard in Wellesley Hills on Friday evening, June 6, after the campus cocktail party. The weather didn't cooperate very well but with everything moved inside, nobody cared. Hors d'oeuvres for the cocktail hour were provided by several of the wives, while Jan Barnard and Jean Machen had prepared a delicious buffet featuring casserole dishes with hot biscuits, salad and dessert.

Those present, in addition to the hosts, were, Hope and **Randy Binner,** Harriet and **Ed Blake,** Mildred and **Wy Boynton,** Dorothy and **Dave Buchanan,** Margaret (Mrs. **Karl T.**) **Compton, Art Donovan,** Ethel and **Tom Fearnside,** Polly and **Ken Germeshausen,** Charlotte and **Ed Hubbard,** Naomi and **Dan Johnson, Bob Leadbetter,** Sally and **Art Newell,** Laura and **John Olsen,** Evelyn and **Howie Richardson,** Fran, Roddy, Louise and **John Swanton,** Thelma and **Chuck Turner** and, as guests, Phyl and Don Severance. Last-minute changes cancelled out Laura and **Fred Damiano,** Olive and **Hal Gurney,** Fran and **Ham Minnick,** Hester and **Ted Morrill,** Peg and **John Robins** and Dorothy and **Harold Wilson.** Harriet and **Shel Smith** were at some of the Alumni Day events but couldn't arrange to join the party in Wellesley Hills.

A class meeting during the affair considered the pros and cons of a number of locations for our 45th reunion next year. There were impassioned descriptions of the charms of Mauai and Puerto Rico and Bermuda; but after full discussion it was voted that the class officers should select a reasonably nearby location that would be convenient for the largest number of our classmates. Howie Richardson was calling a meeting of class officers for this purpose early this summer, and you can safely begin your plans to attend the reunion. . . . A note from **Leonard A. Schuttig** tells that he has been in business for himself since 1941, after resigning from Executive Engineer of Bendix Radio. Leonard's greatest contribution to Bendix was as Project Engineer of the BC-221 and LM series of frequency meters. Although "retired" for about ten years, Leonard still works five or six days a week during the summer in marine electronics. He lives on the Severn River, about two miles from the Naval Academy and has two grown sons of his own, plus another from a second marriage. His health is excellent and as a hobby, he is a professional captain and has been piloting yachts between New York and Miami for about 20 years. . . . **Paul Semple** has been retired since February, 1969 and keeps busy doing personal income tax returns from January through April each year. As a director of Western Oil & Minerals, he visits New Mexico at least once a year. Paul and a 1947 M.I.T. alumnus study cyclical trends in the stock market and as a member of Club Americana, he has been to the Canary Islands, Hawaii and Las Vegas. . . . **Fred Weeks** says that since his retirement from the electrical manufacturing business several years ago, he has been presenting travel slides from his 35 mm colored films to school groups, service organizations, town clubs, garden and country clubs.

John Tillinghast is reported to have retired to Longboat, Key, Sarasota, Florida. . . . **Henry Randall, Jr.** writes that suburban Washington continues to be his home and expects to continue his retirement there for some time. . . . **William Henry Weeks** tells us he retired as Chief Engineer, Manufacturing Division, Federal Aviation Agency and is now working as an aviation consultant. He has served in many aircraft accident cases as an expert witness. . . . All the best to Admiral **Cato D. Glover** upon his marriage to Jean McDowell, of Little Rock, on April 5. They first met in Hollywood in 1921 — and Cato says the spark is still glowing.

Word has been received of **Nelson Haskell**'s retirement after 41 years with Texaco in March. Nelson and his wife, Jane, live at 3843 Lakeshore Drive, Port Arthur, Tex., and plan to remain there. They have a son and daughter. After obtaining his master's degree in business administration from Harvard in 1933, Nelson joined Texaco as an accounting trainee at the Texaco plant in Lock-Port, Ill. He went to the Port Arthur plant in 1939 as a chemist and worked in cracking research, becoming supervisor of gas processing and naphtha-stabilization research in 1941, then supervisor of fuels research in 1943, assistant superintendent of product control in 1954, and chief supervisor of product control in 1958. He retired as the manager of administrative services. Although it wasn't mentioned in the article I received, **Larry Barnard** writes that Nelson had several patents to his credit in 1954 and, 20 years later, in 1974, he and two of his men received a pat-

ent for an automatic apparatus involving a computor. We all hope to see Nelson and Jane at our forthcoming reunion.

In case you haven't seen it elsewhere, our class has been honored by Howie's election as new President of the Alumni Association. This is the second time we have been honored in this way, since **Gil Roddy** served as President of the Alumni Association during 1957-58. Also, congratulations to **J. Kenneth Jamieson** and **Howard Richardson** upon their election to the Corporation of M.I.T. — **Edwin S. Worden,** Class Secretary, 35 Minute Man Hill, Westport, Conn. 06880; **Ben W. Steverman,** Assistant Secretary, 260 Morrison Dr., Pittsburgh, Penn. 15216; **John R. Swanton,** Assistant Secretary, 27 George St., Newton, Mass. 02158

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A most delightful newsy and informative note was received from **Joe Welch, Jr.** in early June which I am most pleased to share with you in its entirety. "I felt quite let down when reading an issue of the *Review,* some time back, to note there were no notes from '32 until I suddenly realized that it was backsliders such as myself who were responsible for the void; so, for what it is worth, I thought I'd better bring you up to date on my activities. I took early retirement from W. R. Grace Co. when they moved my division south, and since we had always enjoyed our visits to Ireland, we decided to make it our second home. We were fortunate to rent a very attractive furnished cottage near Dublin in a picturesque rural area. We managed to get back to the United States for about three months a year to look after business interests, but we continued to enjoy life over here so much that we decided to make Ireland our permanent home. Three years ago we sold our home in Framingham (which, incidentally, we purchased from **Carroll Wilson** when he went down to Washington with the A.E.C. right after the war) and bought a 50-acre site in the heart of the prime farm land of County Meath. There we built our own home along with such outbuildings as hay sheds, horse barn, cattle sheds, etc.

"Although we are still active in the cattle business, raising beef cattle, most of our activities are connected with race horses. We have horses that run on the flat as well as steeplechasers. We have had a mixed bag of luck but it has been a great deal of fun as racing over here is more of a sport than in the U.S., where it is big business. One of our horses qualified for the English Grand National this year and we had the thrill of seeing our colors in the greatest steeplechase race in the world. As a matter of fact I believe I'm the only M.I.T. graduate who ever had a horse run in the race, but it would be interesting to find out. I only hoped that I could report that our horse walked away with the first prize, worth about $100,000, but unfortunately he came a cropper at the infamous Beecher's Brook jump and was out of the race. The only other American-owned horse, the property of Raymond Guest, did win, and we had the vicarious pleasure of joining him in the victory dinner that night.

"Ireland continues to be a great place to retire to. The friendliness of the people and the gentle way of life make it all very attractive, but the rapid growth in the cost of living the past few years due to the inability of an inept government to control inflation (sounds vaguely familiar, doesn't it) is making it less desirable for anyone with a retirement income. I see or hear from very few in the Class but we did have the pleasure of a day's visit last week from Louella and **Phil Boothby.** Phil is now in retirement and living in North Conway, N.H." Joe's latest address is Oak Lodge, Navan, County Meath, Ireland.

A pleasant note from **G. Edward Nealand** advising of his retirement as Director of Purchasing at the Institute after many years of very dedicated and devoted service. We wish Bunny and Ellie many happy, healthy years of retirement. . . . **Earl F. Anderton** is still enjoying life in Belgium. He has been in Europe for 14 years and recently moved to Antwerp, where he has a beautiful view of the old city and harbor activity. Earl relates that he is now working at the most interesting job of his whole career with the Scott Paper Co. as Executive Director of Scott Graphics International. He expects to retire next year and is busy planning a program. . . . **James N. Demas** retired last year after 26 years as a construction engineer with the Housing Department of the New York Life Insurance Co. and moved to Tampa, Fla., last fall. . . . **L. C. Raymond** stays busily engaged in painting from memory sketches made over the 40 years of mining exploration after retiring as a consulting engineer from Ford, Bacon and Davis, Inc. And my best and most active correspondent, **Jim Harper,** furnishes the following news: **Bob Anderson** has now retired from his civil service position with the Navy Dept., and practices patent law in Arlington, Va. His daughter is a music teacher. Bob works hard at his golf but reports that he still has a slice. He is going to Boston in the fall so that his wife can attend the annual Mayflower Society meeting. . . . **Dwight Ashley** is one of the retired government servants that continues to live in Alexandria, Va., but remains busy sharpening up his contract bridge and his golf. . . . **Bill Glowa** resides in Columbia, Md., and is happy with his photographic hobby and his membership in the Washington, D.C. branch of the New York Explorers Club. He retired from the U.S. Air Force (S.A.C.) and a Department of Defense job several years ago and is an active member of the board of directors of the Armed Forces Electronic Association. . . . **Art La Capria** rides horses near his Laurel, Md., home and keeps contact with the racing stables there. Art has been a widower for some years and has six grandchildren. His real hobby is big game hunting. He bagged a walrus in Newfoundland three years ago and will go after big horn sheep in the mountains of British Columbia early this winter. . . . **Don Rice** of Odenton, Md., retired from government service two years ago and enjoys going sailing with his wife in a 30-foot vessel, motor equipped. Don says that with three sons now out of college he can really relax. . . . **Thieman Offutt** our perennial bachelor artist is still residing in Towson, Md. He is complacent and happy with his minor hobbies of music and reading. . . . **Bob West** of Silver Spring, Md., retired from his position of making relief maps for the Army. He has a second home in Maine and is now a sailing brother at Martha's Vineyard in a 40-foot sloop. As a member of the scientist/engineer "Abra Cadabra" Club of Washington, D.C., Bob has made extensive presentations on Unidentified Flying Objects (UFOs). He assures us that they are ghosts in space without any physical substance or solidity and have no physical threat or potential danger to our planet. — **John W. Flatley,** Secretary, 6652-32nd Street N.W., Washington, D.C., 20015

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Top billing this issue goes to **Lobby Lobdell,** who announces that he will surely attend the Mexico City M.I.T. Club Fiesta in March '76. (You will already have received a letter covering all we now know about this off-year, unofficial reunion of our class.) Lobby is very much a faithful Fiesta man. . . . We have a short note from **Maurice Brashears,** who is highly in favor of setting up a class grandchildren competition. Maurice has nine, which is a great start. Who has more? I implore **Guido Garbarino** to top the above figure, if he can. He is already champion of the child competition, and may well be in line for a further title. Only legal grandchildren should be counted, says Lobby. . . . Several brief communications from **Beau Whitton** — first a phone call from Massachusetts, where he was spending a night after picking up his professor son in New Brunswick. Said son might stay with the business, and help Beau get himself rehired; I know Beau hopes so. The Whittons are set to visit England in September. . . . While in Boston, Beau talked with **Tom Galvin,** who is back to work, after his stroke, with the O'Commor firm. Tom relies only on a cane to help steady himself; good for you, Tom. . . . Beau was unable to locate **Gene Sullivan.** The connection here is that Beau, Galvin, and Sullivan were course-mates in Course XVII, Building Construction.

John Trump, Professor Emeritus of Electrical Engineering, and Director of the M.I.T. High voltage Research Lab, has been awarded an Honorary Fellowship in the American College of Radiology, especially for the development of Cathode Ray, treatment of superficial skin malignancies. . . . We have a delayed Christmas message from **Bob Wellwood** — delayed first by him and then by me. Bob and Gladys live in Charleston, W. Va., where Bob is engaged in getting coal out of the mountains. He says he works on conveyors, but there must be an adjective missing; he can't be handling coal himself. Bob has an antique Lincoln convertible, which was displayed in the first annual antique automobile show in the Charleston Civic Center on Labor Day. I expect that the Wellwoods' trip to Scandinavia was their year's highlight. With only two weeks, they covered only Norway and Denmark, but they did it with a vengeance.

Cornelius Weygandt reports: "I am retiring after 40 years of teaching Electrical Engineering at Penn's Moore School. Best regards to what's left of Course VI, 1933." Gee, Con, there's a heck of a lot of our Course VI still extant. . . . It seems that **Al Payne** is all set to enjoy "gracious" Florida living. He arranged a year ago to have a house built in Sun City, but, as might have been expected, when the Paynes arrived in Florida, the house was far from ready, and it took two months to finish it up. Al now talks about the various golf courses nearby. The Paynes have five daughters, three of them

Betty's, and two Al's. Inasmuch as these gals live all over, Al observes that they offer five chances to escape gracious living during the necessary future visits. . . . On June 28, Miss Susan Ellis Littmann was married to one Robert Noel Shulte. It really must have been quite a party, as Roz and **Ellis Littmann** could not do the job any other way. As Classmates, we send the happy couple our very best wishes. The groom is an M.I.T. man (B. S. from the Sloan School) and there were three more M.I.T. men in the wedding party. So Ellis, you are far from derelict in making news for us.

We have a philosophical message from **John King,** of the Cleveland Kings. If you can't lick 'em, John notes, join 'em. John is not in love with his city politicians, and can't communicate with them, so he is running for the City Council of Euclid, Ohio. His lovely Mary is already in politics, as a member of the school board. She is running for her fifth term on the school board, which seems to be the best in Ohio, and she wants it that way, especially for her grandchildren. Dedicated folks like these two are just a joy. . . . From York, Penn., comes a letter from **Neil Hopkins,** retired from engineering with the York Corp. This couple has an almost unbearable situation: Ruth Hopkins has Parkinson's disease, and has become almost helpless. With the help of a visiting nurse, Hop does all the housework and gardening, caring for Ruth as best he can. Hop says that the disease is much more common than is generally realized, and asks that other classmates in similar trouble get in touch with him — there might be a chance for mutual discussion and help. Hop is still the local chairman for the Alumni Fund, and has been for five years. He sings in the bass section of the church choir, and is a member of the York Symphony Chorus. As students, we were quite close; in fact Hop carried a few of us right on his back. I suggest that those of you who knew Hoppy when we were all younger, drop him a line.

One of ours has passed on: **James R. Welch,** of Belmont, Mass. I have written to Mrs. Welch, extending our sympathy as a class. Perhaps some of you knew Jim, and may wish to write. I have the address. — **Warren J. Henderson,** Secretary, Fort Rock Farm, Drawer H, Exeter, N. H. 03833

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Three of our members have been honored by election to the National Academy of Sciences — **Henry N. Andrews** who has been a Professor of Biology at the University of Connecticut; **John A. Hrones** of Case Western Reserve University at Cleveland, for his contributions as a teacher and administrator, his pioneering work in the field of automatic control, and his leadership in engineering education; and **Frank R. Milliken,** President of Kennicott Copper Corp., for the development of processes for the leaching of copper from waste smelting, the use of ilmenite in the production of titanium, and the treatment of deep sea nodules.

A member of our class has just been elected to a five year term on the M.I.T. Corporation. He is **Wilfred D. MacDonnell** of Bloomfield Hills, Mich., President, and Chief Executive Officer of Kelsey-Hayes Company. . . . **Felix Conti,** President of T & B Construction, Inc., in Somerville, has been elected Vice President of the Associated General Contractors of Massachusetts, Inc. Conti is a long-time member of the Association, which represents 130 major contractors who perform three-quarters of the commercial, industrial, and public buildings in the State. He has been on its Board of Directors, and has been its Treasurer. He is currently Chairman of its Building Code and its Licensing Committees. Conti is also active in Carpenters Affairs and serves as Chairman of the Board of Trustees of their Pension Fund and their Health and Welfare Fund.

After twenty-eight and a half years with U.S. Steel, **Bill Coleman** is retiring from his position as Manager, Systems Technology on August 31. He and his wife are moving to St. Petersburg, Fla., and a house just off the Treasure Island Causeway on Boca Ciega Bay. His earlier career included a short stay with R.C.A., five years in the Army, and seven years with the Pennsylvania Railroad. His new address will be 1148 79th Street South, St. Petersburg, Fla., 33707, where he will welcome visits from any of the old gang. . . . **Mal Stevens** has retired from his position as Vice President for Administration at Brown University. He will continue as a Special Adviser to the President of the University and as manager of a 300-acre tree farm in New Hampshire that is owned by his family. After graduation, Mal went to the Panama Canal Zone for three years, returned to M.I.T. and earned his Master's Degree, and entered the Army in 1940. He served in the European Theatre, where he received a Bronze Star and five battle citations. After serving on the Administrative Staff of M.I.T. until the early 1960s he went to Brown in 1962. Mal lives in Barrington, R.I. with his wife Julia. They have three children; a married daughter in Palo Alto, Calif.; Malcolm Jr., who is in the Coast Guard at Warrenton, Oregon; and a daughter, Carla, who lives at home. Mal is past President of the University Club of Providence, Trustee of the Rhode Island School of Design, and a Member of the Rhode Island Post Secondary Education Commission.

Having dinner with two classmates (**Art Manson** and yours truly) appears to have stimulated **William S. Matthews.** Along with a contribution to the Alumni Fund he sent a description of an adventuresome trip through Central America into Costa Rica. He writes, "My son David, 17, and I went as far as the Panama border last summer during the rainy season looking for Indian ruins. . . . They told us in Guatemala City that we should not attempt to go to Tikal in the rainy season, so we flew in to that beautiful and fantastic ruin. They also told us the road to Copan was impassible, but we made it in the old Chevy truck, and were marooned for two nights in a little Indian village of El Florido on the Honduras-Guatemala border. . . . In driving across Honduras into Nicaragua, we spent the night at a little mountain inn, no sheets on the beds, but many blood stains on the mattresses. . . . Two beautiful nights were spent on the beach of Lake Nicaragua, watching the volcano Conception spit and sputter. . . . We got on the banana train at San Jose and rode it through the canyons and forests and the plantations of coffee, cocoa and banana. Ten miles from Port Limon the tracks came out on the Gulf. It was full moon, the waves came in breaking on the white sand of the beaches, the tall palms like columns in a cathedral. It was a breath taking, heart-catching sight. In all we went 800 miles in an eight weeks trip." Bill apologizes for his long silence, broken only by this travelogue, which unfortunately had to be shortened here. He writes that he has had many interesting experiences in the years since leaving M.I.T. and hopes that someday the literary muse will strike him again. So do we! — **George M. Bull,** Assistant Secretary, 4961 Allan Rd., Washington, D.C. 20016; **Robert M. Franklin,** Secretary, Satucket Rd., Brewster, Mass. 02631

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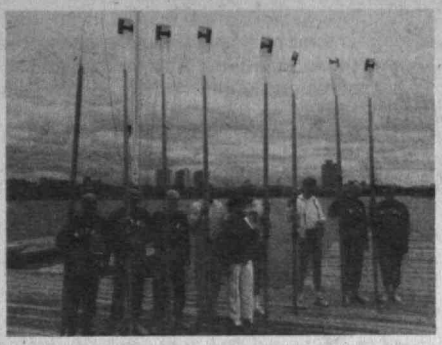
The Fortieth is now a most pleasant memory to the 80-plus classmates and 45 wives, guests and widows of classmates who spent a long week-end together June 5 to 8. There was general agreement that this was the best reunion yet and accolades were heaped on **Ned Collins** and **Rufus Applegarth** and their committees for the fantastic job they did. It was a brilliant maneuver to hold the Class Meeting after breakfast on Saturday morning when *everybody* was there. Never have so many voted at our meetings before. The new officers elected until their successors are chosen five years from now include: President, **Bernie Nelson;** Vice President Northeast, **Ned Collins;** Class Agent, **Leo Beckwith;** Class Estate Secretary, **Rufus Applegarth;** Treasurer, **Randy Antonsen** and Secretary, **Allan Mowatt. Hal Bemis** as Chairman of our 40th Reunion Gift Committee announced our gift of $1,427,000 at the Alumni Day luncheon. At the request of the new class officers up to $25,000 of our gift is being allocated toward covering the deficit of the Historical Collection. The Class of 1925, the 50 year class, also voted the same amount. The Alumni Association office plans to issue a list of the names and addresses of all living members of our class including the class widows. It will be mailed to all who attended the Reunion. If you would like one and for some reason or another were unable to attend the reunion, then please let me know. For at least a few of us the real highlight and climax of the reunion was having eight men of our class put in about a half mile or so of rowing in an eight-oar shell. **Lee Abramowitz** was honorary coxswain for the crew: **Jake Leeder, Pete Grant, Charlie Debes, Whit Stueck, Bob Olsen, Stocky Stockmayer, Art Haskins** and **Allan Mowatt.** Jake Leeder was the real hero by volunteering to row when one of our oarsmen couldn't make it at the last minute. We gave Jake a quickie course in rowing in the tank of the new boathouse a half hour before we went out and all went well. In other words no one fell out, the boat stayed upright and we all maintained our dignity in front of the myriad of cameras aimed at us by our friends.

This next is a letter written by **L. Guy Haines** whose address is 13 Cressington Place, Bourne End, Bucks, U.K.: "I take exception to your assumption that I haven't pulled an oar for forty years. About 26 years ago I joined the Sheridan Corp., a manufacturer of large automated book binding lines. After about 17 years of managing one of their plants I was requested to go forth and find a manufacturing facility in Europe so that we could be more competitive in this



Not the sunniest day for a race, but determination sparked the 40th Reunion crew of the Class of 1935

market. . . . So I found myself with Helen, of course, working in Slough, about 25 miles west of London and living in Bourne End which is within minutes of Windsor, Maidenhead, Huxley and is on the River Thames. The coincidence is that my father, "Bill" as you knew him, was born in Windsor and grew up on the Thames in this area. After he retired from M.I.T. in 1936 he retired to England in 1939. During the war he volunteered for fire watching duty and patrolled the roofs of factories on the same Slough Trading Estate where I am located by fate today. I am a member of the Marlow Rowing Club, have a single there which I row at reasonably regular intervals and keep myself in half way decent condition. We also have a double kayak and Helen and I are on the river quite often on weekends. By carrying the boat on top of the car we have been able to explore and enjoy most of the Thames. The Thames is a unique thing and is probably better described as practically a separate society. It is beautifully maintained and a delight to use. I wish very much that we had its equivalent at home.

"It would appear that with normal business we would continue here for two more years when I expect to retire at 65. We have been in Europe about four years now and I must confess I find it a most interesting market. I have been thinking that the ideal retirement might be to become associated with some company that needs some presence in Europe for say part of the year. Some day, I am sure we will be in the same area at the same time and when that happens I would be more than delighted to pull an oar with you." With a little continued good luck I may get to row with you on the Thames before those two years pass.

From our correspondent in Sweden, **Bob Forster,** comes this latest: "Connie and I went to Brussels for a week (in July), me for a meeting. Two weeks before that we spent a week in Northern Sweden with four days above the Arctic Circle. Saw the midnight sun, reindeer, Lapps, etc. A long trip, just under 2,000 miles, but enjoyable and the roads were very good. I have been traveling quite a bit and Connie and I have played golf only three times. Next week we are going to Finland for a week and go again in mid-August, also to Oslo and Copenhagen. Just received a letter from **Nix Dangel** that he and Sarah are coming to Stockholm in mid-July, but unfortunately we will miss them as I have to be in Finland. Never a dull moment."

Dick Bailey wrote, "Sorry I can't make the reunion. My wife will be working and there are other complications. Hope you all have a great affair and give everybody my best regards. I am playing golf and tennis like mad and enjoying every minute of it. My new marriage is going great and makes me feel very grateful for all the blessings I have received. Wish I could have shown off Barbara but it isn't in the cards." . . . **John Kiker** wrote from Americus, Ga.: "I do not remember having ever received a more welcome letter than yours and am enclosing my registration to get back into the golf matches. You'll note my golf has deteriorated. I have yet to break a 100 on the Americus course but made just that yesterday. Am now married to the widow of my best boyhood friend and am happier than ever. With this runaway inflation, however, and being retired on a fixed income, I'm going to have to miss the 40th Reunion. We have a comfortable home on Lake Collins (named for my wife's first husband) and a guest room on permanent standby."

Charlie Piper came to reunion and as he said to me afterward, it really "turned him on" and he was anxious to go back and telephone all our classmates in his southern California area that could not attend to tell them what they missed. I spent an evening with him at his hotel recently when he made a return trip here on business. Besides seeing some astounding three-dimensional (stereo) pictures he took at reunion, we had a chance to talk about many things. I learned about his wife of 35 years, Jean, who "dabbles in real estate." I learned that Charlie is a Charter Member and former President of the T.R.W. Chapter of the Toastmasters Club of Southern California. He is currently the equivalent to Program Chairman. He is President-elect of the Stereo Club (camera not sound) of Southern California which has a membership of 65. One of his hobbies is the repair of stereo cameras which haven't been made for years. He has a Three Star Rating with over 100 acceptances at the International Salon for Stereo pictures, one of the many Salons sponsored by the Photographic Society. In all, he has over 120 acceptances of 24 different slides. One of the things that Charlie Piper would like to have most is a copy of our 1935 *Technique*. If anyone has any ideas to help him on this, please write to him at 26810 Fond Du Lac Rd., Palos Verdes, Calif., 90274, he would surely appreciate it.

I have been having a great time playing golf with some of our classmates, mostly weekends, but sometimes as an afternoon break on a business trip. So far I've played with **Ned Collins** at Easton, **Bob Flood** at Winged Foot, **Sam Brown** at Canoe Brook and **Al Johnson** at Bear Hill. Bob knocked me out of the first flight and Al finished me for the season last week. But I have lots of plans and hopes to see and play with a lot more by the time this reaches you. I am delighted to also report that my correspondence pile is as big as ever so you will have meaty notes to read for months. You might as well start now to add to it. — **Allan Q. Mowatt,** Secretary, 61 Beaumont Ave., Newtonville, Mass., 02160

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As our 40th reunion approaches some classmates are retiring. One of these is **John Ayer, Jr.** . . . On the other hand some are accepting new responsibilities. **Roman Ulans** writes from Singapore to report that he is being transferred to Geneva, Switzerland and will assume the position of Director, European Office of the Communications Satellite Corporation. He and his wife, Morwenna, will be happy to welcome any of you at 3, place Isaac Mercier, Geneva. Your secretary is sad he has left Singapore just when she had thoughts of heading in that direction. C'est la vie! . . . **Henry McGrath,** our indefatigable reunion chairman reports that for the past three years he has been Director of Processes for Procon, Inc., an international engineering-construction company serving the oil, gas and chemical industries. Company headquarters are in DesPlaines, Ill. . . . Witco Chemical Corp. has formed an Inorganic Specialties Division and **Charles Saffer** has been appointed technical director. . . . The *Boston Globe* last June carried a feature article about a senior resident at Massachusetts General Hospital who was scheduled to be flute soloist at M.G.H.'s "Night at the Pops." The flutist is Dr. Eve Slater, daughter of our own **Philip Slater.** She has studied flute since fourth grade and while at Vassar and Columbia's College of Physicians and Surgeons. . . . **William Williams** reports that he has just been granted his fortieth patent and is "happily still cooking up new ones."

At M.I.T. Night at the Pops I shared a table with Rose and **Ed Dashefsky** and Fran and **Leo Kramer.** The following day on campus I saw Elliott and **Dick Denton,** who was in Boston from Cherry Hill, N. J., on business. There were other class members listed as attending but I didn't see them and the Alumni Office did not send on that list as usual so I cannot report to you. Remember our 40th is coming. I hope to see you all then. — **Alice H. Kimball,** Secretary, P.O. Box 31, West Hartland, Conn. 06091

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Reland Westgate is President of XYLO Inc. of Savannah, Ga., manufacturers of wood picture frame moldings. His new address is 1760 Porpoise Point, Wilmington Island, Savannah, Ga. 31410. . . . **Fred Altman** retired from Computer Sciences Corp. in March, 1973, and is doing some consulting work. He and his wife have been doing some traveling, to Hong Kong last October and Rio in April. . . . **Gray Jensvold** recently sold a house to Stuart Weppler in Vermont. Stuart is the son of **George Weppler,** and Gray reported that George was seriously ill. Since then I am sorry to report, George Weppler, or Bob, as many of us called him at M.I.T., died on June 22, 1975.

Bob was Chairman of the Board for Harvey Hubbell, Inc., in Orange, Conn. He leaves his wife, the former Cornelia Menard, three sons, two daughters and two grandchildren. We extend our deepest sympathy to his wife, Cornelia, and their family.

Gil Mott was President of Olin's Aluminum group, which was sold about a year and a half ago, and since then has been working on corporate matters, including planning and acting as Chairman of the Investment Committee. His three children are getting near the end of their educational careers. The youngest has just completed his freshman year at Trinity. The oldest boy graduated from Princeton in 1973 and since has been studying music at the Conservatory of Music in New England. Betsy graduated from Smith this June and is now contemplating the next phase of her career.

Your Secretary has received an announcement of the marriage, on June 28, of Catherine Carson Leffel to Alan Jeffrey Birch, son of Elvie and **Norm Birch**. . . . **Dick Lamphere** writes that he is now unemployed and spends his spare time in the pursuit of fish from the Arctic Circle to Southern Florida. . . . **Martin Kuban** is a Project Engineer for Logemann Bros. Co., Milwaukee, Wis., builders of material recycling machinery. They have just shipped into Montreal, Canada, one of the industries' largest hydraulic steel-mill scrap compressing and shearing systems. — **Robert H. Thorson,** Secretary, 506 Riverside Ave., Medford, Mass. 02155; **Lester M. Klashman,** Assistant Secretary, 198 Maple St., Malden, Mass. 02148

38

You should by now be well aware that class prexy **Norm Leventhal** has been elected to the Corporation of M.I.T. for a five-year term. . . . **Ben Epstein,** Professor, Faculty of Industrial and Management Engineering, Israel Institute of Technology, was selected as 1974 Shewhart Medalist of A.S.Q.C. "for his fundamental, original, and endearing contribution in the assurance sciences; reliability, availability, and maintainability." This distinguished award is presented to the individual who has made the most outstanding contribution to the science and techniques of quality control, or who had demonstrated outstanding leadership in the field of modern quality control.

A news release states that **Don Macdonald,** Associate Professor of Political Science, has been given an extended leave of absence from East Stroudsburg State College to accept an appointment as International Relations Officer of the United States Forces, Korea. Scheduled to begin duties in June, he will be stationed at U.S.F.K. Headquarters in Seoul. His work will deal principally with the maintenance of good community relations between the people of Korea and the American military forces stationed in that country under the bilateral mutual security treaty of 1954.

A note from **George Wood** tells us that he retired from Convair (Instrumentation) and is working on marine, automotive and musical schemes which may yet make some dollars. . . . **Joe Vallone** writes that he is semi-retired — now Secretary of the Rhode Island State Board of Elections. — **A. L. Bruneau, Jr.,** Secretary, Hurdman and Cranstoun, 140 Broadway, New York, N.Y.

39

Billie and **George Cremer** will be visiting Europe again, this time to tour southern England during July-August. . . . **Al Schreiber** is dividing his time between his electronic manufacturing business at San Clemente, Calif. — sharing his beach with our former President — and visiting Mexico again where, this time, he'll make some archeological and marine studies. . . . **Gordon Holbrook** sent a two-page article from the July, 1975, *Gourmet* magazine. The article contained details and compliments about **Dick Cella**'s famous New York restaurant. Special thanks to Gordon for his thoughtfulness in writing and to Dick for giving him the extra reason. . . . Connie and **Manning Morrill** have moved to Winchester, Mass., where they will establish residence and manage three operating divisions of Hersey Products, which makes meters and controls. I can't resist saying we hope the results of all this turn out to be sweet. . . . **Larry Perkins** is President, owner, and Chief Holder of the Broom at Connecticut Container Corp. When he hasn't been busy administering, entrepreneuring, and sweeping, Larry has applied his energies to establishing a subsidiary plant at Marlborough, Mass., raising two daughters who, in turn, married attorneys and presented him with three grandchildren; and raising a son who now studies engineering at Univ. of Penn.

Irv Peskoe recently visited Easter Island and Macchu Picchu (Peruvian Andes) and was fascinated with the marvels. Irv, please tell us your theories about how such big rocks were moved around so long before there were cranes, and how such close-fitting lenticular junctions were made between 20-ton rocks before there was much knowhow to make metals or to create tooling. . . . **Frank Sargent** has been conducting seminars at Harvard and may expand his activities to lecture at M.I.T. . . . **H. King Cummings** was reelected to his second term on the Board of Trustees at Colby College. He is President of Guilford Industries, Maine, and Coin Industries, N.Y. . . . **Harold J. Muckley** was elected to a five-year term as a member of the M.I.T. Corporation.

For those of you who will follow **Gordon Holbrook**'s example and send along some news bits, please note the different address: — **Hal Seykota,** Secretary, c/o Birchall, 335 Second St., Atlantic Beach, Fla.

40

Our seventh quinquennial! **John Danforth** has graciously reported for us the 35th reunion of our class.

"The 35th reunion at Chatham Bars Inn on Cape Cod this June was very successful. Jane and **Jim Rumsey** in their brilliant series of letters persuaded over one hundred to attend. Everyone had a good time and was glad they came. **Ted** and **Edith Kingsbury** as Vice Chairman and Treasurer made all the arrangements so necessary even for an informal occasion.

"The weather was mostly good with Saturday an ideal Cape Cod day. Chatham Bars served excellent meals and otherwise took good care of us. The lobster picnic on Sunday did bear some resemblance to a winter outing in the cold wind from the ocean. There were serious golfers led by **Joe Jefferds** and **Sam Rabinowitz** and a strong tennis contingent led by the trio of **Duffet, Wright** and **Kaneb.**

"It was a chance to renew old friendships and make new ones. Our class is indeed large. We can look forward to an even better reunion in 1980." That is, our eighth quinquennial!

The 35th for '40 was a time for "hail and well done" to **Alvin Guttag.** Al, as every reader of the notes over many years must know, has served as the Secretary of our class (its Treasurer, too) for 25 years. He has confessed to missing the deadline for submission of copy to the *Review* just once in all that time. A most difficult act to follow. Please, then, take note. Your news now should be sent to **Frank Yett** (address below).

W. H. Krome George, President of the Aluminum Company of America since 1970, was elected Chairman of the Board in June, leaving the president's chair, but continuing as Chief Executive Officer. George started the ladder in 1942 when he joined Alcoa as a chemical engineer. . . . **Sylvia Reay** stayed in Berkeley, Calif., so her nephew, Steve Shimberg ('61) could visit her this June. He's with I.B.M. in Ohio. . . . **Leonard Weaver** completes his ninth year as Product Development Manager of Bird and Son, Inc., and his 26th year with Neponser Choral Society as music director, all in Roxboro. He has five grandchildren. . . . **Clem Burnap,** much traveled professional in U.S. and the European scene, continues work on iron ore, uranium and chemical fertilizer plants all over the world.

Irving Chase, President of Henry Thayer Co, food products, this June married Mrs. B. Crowninshield Bailey. The vows were exchanged at the home of the bride, Wayside Farm, Lincoln, Mass. . . . **John Joseph** announced at the Chatham Bars reunion that he would be marrying Patricia Stryker two weeks later.

Ted Kingsbury and **Edith Kingsbury,** née Cameron, have let us know that the 100 in attendance at our reunion were 46 couples and 8 singles. A well-settled alumni group. — **Frank A. Yett,** Secretary, 254 S. Euclid Avenue, Pasadena, Calif. 91101

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You should know that **Charlie King** was the Director of Engineering for the Apollo-Soyez Flight program. For a fellow chemical Engineer that's great. . . . **Will Mott** informs us that the company he worked for 19 years decided to go out of business. He is now a Market Consultant and Manufacturers Representative for companies who want to sell to the nuclear utility industry. . . . We note that **Reid Weedon** was re-elected to a five year term on the M.I.T. Corporation. . . . Halcon elected **Ralph Landau** Chairman of the Board. Ralph has also been elected to the National Academy of Engineering. . . . **Frank Walker** of Miami Shores has been elected to the Board of Directors of Community Federal Saving and Loan Association in Palm Beach County, Florida. Frank is also owner-partner of Home Underwriters of Miami and has his own research and development laboratory for the discovery of patentable ideas.

News in general is that **Leon Punsalan**

has been teaching on the Eastern Shore since he retired from the Army in 1963. He attributes his success in finding teaching jobs to his "Good Old M.I.T. Credentials." . . . **Jacob Berezow** celebrated his birthday recently with a blocked kidney and ruptured prostate. He says "All my plumbing is now under control." . . . **Mason Miller** informs us that he is with the G.E. Aircraft Engine Group in Ohio as Senior Systems Engineer. . . . **Bob Purvin** has been elected Chairman of the Board of Purvin & Lee, Inc. of New York. . . . An article in the Pittsburgh Press featured **Gene March,** Colt Industries Group Vice President. The Crucible Division employs 5700 and has been hurt by imported steel.

Keep on sending in your News! — **Henry Avery,** Secretary, U.S.S. Chemicals, 600 Grant St., Pittsburgh, Penn. 15230

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Our class can be justly proud of the recent appointment of **Ken Wadleigh** to the post of Dean of the M.I.T. Graduate School, and we wish him well in this most prestigious position. Ken has been a member of the mechanical engineering teaching staff at Tech for 29 years. He received his Sc.D. in 1953 and became a full professor in 1961. From 1961 to 1969 he served as Dean of Student Affairs, and has been an M.I.T. vice president since then. The graduate school has 3,500 full time students, compared with 4,100 undergraduates. As vice president, Ken has recently had administrative responsibility for Tech's Medical Department, Registrar's Office, and for coordinating the academic calendar and the major campus and off-campus housing programs.

Peter von Wiesenthal wrote recently with the news that he is President of Heat Research Corp., a subsidiary of Pullman Corp., and travels between Houston and New York, having offices in both places. He also makes trips to Europe and Japan. His son graduated from The Hill School this year and his daughter is a junior at Sweet Briar. . . . **Virgilio Barco** was re-elected to a five-year term on the M.I.T. Corporation. He lives in Bogota, where he is Senator of the Republic of Columbia for the state of Cundinamarca. . . . **Frank Finney** has been named Managing Editor of the *Oakland Tribune* (California). . . . Dr. Ross Golden, husband of classmate **Frances Kraft Golden,** died last January in Laguna Hills, Calif., where they have been living in retirement at Leisure World.

With sadness I report that our beloved classmate, **Ted Lindsay,** passed away in June. After graduating in Course XIII-C, Marine Transportation, Ted sailed on merchant ships as engineer during World War II, ending up as Chief Engineeer and Lieutenant Commander, Maritime Service. In 1961, after working for Lake Tankers Corp. and Allied Chemicals in marine shipping work, he became an independent marine and shipping consultant, with offices in New York City. He was instrumental in the development of the first all aluminum ocean ships and barges. Ted, who lived in Mineola, N. Y., was married to Dorothy Lee Cole in 1944. He wrote a most beautiful letter for these class notes in 1966, in which he described, with deserved pride, his wife and children's activities and accomplishments. Dorothy wrote me, in response to my letter of sympathy to the family, that in spite of Ted's long and terrible illness he was able to attend their son's and daughter's graduations from Harvard in 1972 and 1974, and their marriages. Some of you may recall that Ted's sister married his roommate, **Jim Harno.** As Donne wrote, "any man's death diminishes me," which makes writing the class notes sometimes a little difficult. I'll leave you now to drive home along the beautiful Pacific Ocean, and perhaps think about the sea's serenity. — **Richard M. Feingold,** Secretary, 3757 State St., Santa Barbara, Calif. 93105

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We received a letter from **James C. Ray** in June which we are happy to share with you. Jim was one of those who lost his position at Lockheed in California in 1973 when the cut-backs occurred. For nine months Jim sought new work and is now happily established in Denver as Test Controller with Hughes Aircraft. Jim is working under a Hughes contract with the Air Force but he is unable to advise the aspects of his work. Jim, his wife, Bettie, and their two boys, 15 and 13, have switched from the skin diving enthusiasts they were in Calif. to tennis buffs in Denver. Jim and his boys are also backpacking with the Colorado Mountain Club.

Fran and **Jim Corbett** report from their Long Island home that their daughter, Marsha, has recently been married in Conn. One son is a sophomore at the University of Maine in E. E., the other son is in his third year in high school in Centerport, L.I., N.Y., and headed for pre-med. Jim reports he is still at Grumman Aerospace with other classmates, **Arnold Whitaker** and Joe Gavin, '41. . . . A short note from **Don Burke** down Florida way advises he, his wife and four children spent time last year vacationing in Vienna, Hungary and Yugoslavia. This year they will be more restricted in their vacation travels. Don would love to have visitors come to see him in Florida. . . . **Richard Riley,** Capt. U.S.N. (Ret.), is the administrative manager, in operations, for Iowa Power and Light Co. His staff of operations anaylsts and engineers is engaged in a variety of projects spanning the spectrum of electric and gas utility operations. . . . **Robert E. Michaud,** '47 has joined Incoterm Corp. in Natick, Mass. as program manager. . . . **Monroe M. Gliedman** recently had a Fellowship with the American College of Dentists.

David J. Tobin died May 8, 1974, at his home in Hisdale, Ill., of coronary failure. Mr. Tobin had been Secretary of Foundations at M.I.T. beginning in 1964. In 1967 he became the first Institute Secretary for Charitable Trusts. In 1972 he assumed the post of Special Assistant to the Vice President and Secretary of the Institute to strengthen the administration of the Corporation Visiting Committee. Dave left M.I.T. in March, 1973, to join the Institute of Gas Technology in Chicago. Dave is survived by his wife, Louise, and their children. — **Russ Dostal,** Secretary, 18837 Palm Circle, Cleveland, Ohio 44126

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Work on the golf course has precluded my doing a lot of other things, these notes included, so I will be brief.

Congratulations to **Mary Wagley** for being re-elected to a five-year term as a member of the M.I.T. Corporation. She is headmistress at St. Paul's School for girls in Brooklandville, Md. . . . **Ed Brandeau** has been appointed Manager of New Business Development at the Brand-Rex Co. in Willimantic, Conn. He was an electrical engineer at school and also has L.L.B. and M.B.A. from Harvard. . . . **Jack Kiefer** is now Horace White Professor of Mathematics at Cornell. . . . **Ken Amer** writes that he and Hedre visited M.I.T. in May for the first time since graduation and were given a guided tour of the wind tunnels by Professor Miller. Ken, you should plan to attend the 30th reunion which is not too far distant. . . . **Larry Powell** writes that his longing for the ocean and Narragansett Bay has led him to breeding and hatching good old New England lobsters in artificial salt water here in Akron, Ohio. He is having fun and a challenge though it has turned out to be a technical tour de force rather than a business venture as planned. I think I understand his problem since for years we had an old style New England steamed lobster party in a pit in our backyard. We stopped as costs became prohibitive and most people in this area are as happy with broiled lobster tails as steamed lobster.

Mildred **Schmidlin** took the time to drop a line advising that husband **Herb** has been promoted to Director of Manufacturing by Raybestos-Manhattan Roll Products of Scranton, Penn. He will stay in Appleton, Wisc., but will oversee the operations of the company's four plants. Herb went with Raybestos-Manhattan in 1958 as a Chemical Engineer in the Passaic, N.J., plant, then went to the Wisconsin plant in 1962 first as Resident Manager then as General Manager. . . . Drop a line — **Dick O'Donnell,** Secretary, 28516 Lincoln, Bay Village, Ohio.

49

As I take up my pen, it is late July — midwinter — in Rio, just warming up after an extended major cold spell that will mean higher coffee prices for everyone this coming year. However, for my classmates, it is too obviously the mid-summer lull . . . in news as well as work.

Douglas M. Van Patter writes on an Alumni Fund envelope of last November's visit to India, where he presented a paper at the University of Delhi to an international conference on "Gamma-Ray Transition Probabilities," followed by a two-week lecture tour to universities and institutes of technology in Kanpur, Chandigark, and Simla (in the Himalayas). . . . **J. M. (Jan) Hoegfeldt** sends a brochure for the Eighth Annual (1975) International Metallographic Convention, of which he was General Chairman, and which included speakers from nine different countries, including Australia, the Philippines, India and Chile. . . . And **George P. Schultz,** our Ph.D. classmate and former Secretary of the Treasury, has been elected to the Board of Trustees of the Alfred P. Sloan Foundation.

That's all for now. Let's hope for all our classmates that no news is good news. — **Frank T. Hulswit,** Secretary, Baras de Torre, 263/Cob. 2, Ipanema, 20000 Rio de Janeiro, R.J., Brazil.

51

Our 25th Reunion is just around the corner, believe it or not, and Co-Chairmen **Dick Reedy** and **Jay Rosenfield** have assured me that it will be the best reunion of all time. Meanwhile, **Breene Kerr** is in charge of raising the Class's 25-year gift, targeted at $1 million.

These '51ers do keep things interesting. **Allen B. Fonda** has an infant son, Howard; **Roger G. Christman** has a boy and girl attending M.I.T.; and **Keith G. Lakey** retired from the U.S. Navy in January, 1975. Presently he is Vice President and Director of East Coast Operations for Catalina National, Inc., dealing in polymerized ferrocement technology.

Planning a greater future: **Edward A. Handy** working for the City of Cambridge, Mass. as Transportation Coordinator and Assistant Director for Intergovernmental Relations and enjoying fairly frequent contacts with M.I.T. staff and students. . . . **Robert O. Crockett, Jr.,** an Industrial Economist with the Bureau of Mines, U.S. Department of the Interior. . . . **Christian C. Bolta,** who has been with the Argonne National Laboratory for five years on fast breeder reactor safety. . . . **William Kenly,** newly hired engineer for the Redevelopment Agency of New London, Conn. . . . and **Dick Ahern** of Detroit, now in his 13th year of private practice of community planning. He adds: "My current avocation is the promotion of a peace and freedom program as part of our bicentennial activities. I would appreciate hearing from local alumni who share such sentiments."

David McCandless, Jr. is teaching architecture (acoustics and graphics) at University of Texas at Austin and Arlington; still doing consulting work in architectural acoustics and much painting with shows for Southwestern Watercolor Society, Texas Watercolor Society, and Texas Fine Arts Association.

Maria A. Bentel of Locust Valley, N.Y., writes that she and husband/partner, Dr. Frederick R. Bentel (Bental & Bental Architects) received five design awards for four completed buildings in 1974 granted by New York State Association, Long Island Association and Queens Chapter, all of A.I.A. Their current assignments are a $10 million aquatics complex for Nassau County, a boys' club for Glen Cove, three public libraries, and a gymnasium and student activities building for New York Institute of Technology. Their oldest, Paul, graduated from Phillips Exeter with high honors and spent the first half of 1975 working with Senator William Proxmire in Washington, D.C. Son Peter has finished his first year at Exeter and daughter Elizabeth is still at home.

Charles E. Maki was recently promoted to President of Theta-Com, subsidiary of Hughes Aircraft Co. Theta-Com makes cable television equipment and systems, also microwave equipment. . . . **Ramon E. Colon** is design engineer for General Electric's F101 Turboform Engine Program and is enjoying it more every day. . . . **Arthur W. Heineck** was recently appointed Manager of Engineering at the Datamaster Division of Acco, Glen Cove, N.Y. . . . **Thomas A. Weil** joined Raytheon Co. in 1951 following graduation and is presently Staff Engineer to the Radar Systems Laboratory Manager. He was recently made a Fellow of the Institute of Electrical and Electronics Engineers for his contributions to radar system technology. He authored the transmitter chapter of the *Radar Handbook* edited by M. I. Skolnick and has a number of patents to his credit; his fields of specialization include high-power short-pulse generation and measurement techniques, and design and development of modulaters, transmitters, and power conditions systems.

Lawrence Kuszmaul, Jr., of Ellicott City, Md., is with Arundel Corp., a heavy construction firm, and is looking forward to the 25th reunion. . . . **H. E. Knipmeyer,** still with DuPont, has returned to Wilmington from Ohio and is currently Technical Manager of the Industrial Division, Film Department. His work includes travel between U.S. and European plants, with a fascinating week in Moscow last year.

We are sorry to include news of the death of **Charles J. Henry,** Bay St. Louis, Miss. — **Fred W. Weitz,** Secretary, 4800 S. W. 74th Street, Des Moines, Ia., 50309

53

Surprise! Six of you folks took the time to drop me a line. That's a vast improvement, though neither my mailman nor I feel the load is yet too heavy to bear.

First, some newspaper and other such notices. **C. Lawrence Bradley,** co-founder and a member of the Board of Directors of the Analytic Sciences Corporation in Reading, Mass., is a candidate for re-election to the Nahant School Committee on which he has served for almost nine years. He has two sons and a daughter, and following his M.I.T. work he received a Master's degree in math from Northeastern University. . . . Here's a new one for you: **Dave Swanson** (now working in the Inertial Division at the Draper Laboratory) finished his second Boston Marathon (in two hours and 59 minutes), bringing his total of marathons to five. He's been running for three years and is part of a Draper Lab group who call themselves the "River Rats" (presumably because they meet daily at noon and run along the Charles River). . . . While I earlier devoted some considerable space to **Bruce Murray**'s doings, it is worth bringing you up to date. He has now been named Director of the Jet Propulsion Laboratory, operated for N.A.S.A. by Cal Tech; there are more than 4,000 employees. Bruce was in charge of the space photography organization which planned and operated the camera systems that returned thousands of brilliant pictures from Mars, Mercury, and Venus. . . . Among the new members elected to the M.I.T. Corporation was **Allan MacEachen,** who is living in Inverness, Nova Scotia, and serving as Secretary of State for External Affairs, Dominion of Canada.

Now back to the "hand-writ" notes from you cooperative souls. **John Horning** reports that he is now "Manager of the Product Engineering Unit at the Liquid Metal Engineering Center, an LMFBR component testing facility run by Atomics International in the Southern California area. Wife Fern (married '54), sons John, 15, Jim, 13. Have been with Rockwell International (formerly North American Aviation) in Rocketdyne or A. I. division since graduation except for three years with Consolidated Controls Corp." . . . **Ben Coe** reports that for the past 1½ years he has been Executive Director of the Temporary State Commission on Tug Hill, a regional study commission of the N. Y. State legislature. "Tug Hill is a 1.3-million-acre wilderness area on the east side of Lake Ontario," Ben writes. "Our job is to make recommendations on the area's future. Land use planning and control is the name of the game. Peggy and the two kids left at home (Margaret and Mary) join me in enjoying New York's North Country — sailing, fishing, hiking, cross country skiing, etc." . . . **Howard Stern** is President (and founder) of EZ-EM, manufacturers of radiological accessories; he and Linda have one daughter, Rachel (7), and one son Seth (5); they "do a lot of traveling and bump into M.I.T. alumni worldwide." . . . **Serope Kalpakjian** notes that he is in the process of revising his textbook, *Mechanical Processing of Materials*. He is the Undergraduate Officer in the Mechanical Engineering Department at Illinois Institute of Technology where he is also a full professor, active in University affairs and also professional societies. His children are now 11 (Claire) and 8 (Kent). . . . **Stuart Soloman**'s wife Roberta dropped me a line in his behalf: "We have been in Richmond, Va., where Stuart graduated from the Medical College of Virginia, for ten years now. He is a practicing pediatrician with Richmond Pediatrics, Inc. We have a son, Scott, who recently graduated from St. Christophers' School in Richmond and is entering Harvard in September. He is a National Merit Scholarship winner and a Harvard Honorary Freshman Scholar. Our daughter Carrie is 15 and a sophomore at the local big high school. We lived in Pittsburgh from 1956 to 1962 when Stu was a metallurgical engineer with U. S. Steel."

Let me hear from the rest of you. — **Martin Wohl,** Secretary, 7520 Carriage Lane, Pittsburgh, Penn. 15221

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John Blair has been named a consulting scientist at Raytheon where he has served as Corporate Director of Research since 1966. . . . **Doug Ross,** founder of SofTech, has been elevated to Chairman of that firm's Board of Directors. Doug recently received the 1975 Joseph Marie Jacquard Memorial Award, the Numerical Control Society's highest accolade. . . . **Emmanuel Pazar**'s son, Steven, recently attained the rank of Eagle Scout. Congratulations, Steven. . . . **Harry Taylor** reports the birth of a son, Lior Aaron, on last December 24. His daughter, Alisa, has recently completed her first year of pre-med at the University of Virginia. Varda and Harry extend their welcome to those of us who may be visiting Israel.

Bill Gouse, Jr., '53, has been appointed Deputy Assistant Administrator for Fossil Energy in E.R.D.A. Any energetic "fossils" can contact Bill in McLean, Va. . . . **Richard Sherwood** is working on facilities planning for Johns Manville's new 60 million dollar world headquarters. . . . **Charlie Smith,** a life long railroad buff and active model railroader back when we were at Tech, is now part owner of a full size locomotive. And they say that yachtsmen are always trading to a larger size! — **E. David Howes, Jr.** Box 66, Carlisle, Mass. 01741; **Charles Masison,** 76 Spellman Rd., Westwood, Mass.

02090; **Lou Mahoney,** 6 Danby Rd., Stoneham, Mass.

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Greetings from the junior member of your new secretarial team. This half feels like a traveling secretary, having been commuting between a home in the New York area and an apartment in Minneapolis since last November for a little trial that has been in progress since that date.

On to those with greater accomplishments. **William Banks** reports he has gone from the moon to the sewers in two and a half years. An aerospace casualty, he has since been immersed in water and waste water engineering. . . . **William Chandler** has traveled an even more exotic route. Bill was recently transferred by the Potlatch Corp. from his post as Assistant General Manager of its Paperboard Div. in Lewiston, Idaho, to McGehee, Ark. where he has been named the Plant Manager of a new $150-million pulp and paperboard mill. At this writing, Bill, his wife Joyce, and their three children are in Arkansas where he is responsible for the construction, start-up and operation of the plant, scheduled to be on stream by late 1977. . . . Coming full circle, **Norm Ness** reports from N.A.S.A.'s Goddard Space Flight Center that he participated in the Mariner 10 Mercury exploration program in March, '74-'75 and, as principal investigator, was involved in the discovery of its modest magnetic field. To show how way out Dr. N is, he was also involved in the detection of Jupiter's complex, high order magnetic field by Pioneer 11 last December.

Charles Ladd noted some months ago that he was "still" a Professor of Civil Engineering at M.I.T., working in the area of geotechnical engineering, but that he was looking forward to a sabbatical this school year. . . . **Marty Raab,** on the other hand, professes to "trying to survive" as a partner in the A/E firm of Haines, Lundberg and Waehler. Marty also reports sending his oldest son off to college this year, and feeling older as a consequence — sound familiar to anyone? . . . Final notes received from **Austin Somes,** whose Amy Catherine joined an older brother and sister in April. Austin tells us that **Jim Thacher** visited him recently. Jim, his wife, and three sons live in Salt Lake City where he works for Hercules.

I join in Allan's recent praise of the 20th Reunion at Martha's Vineyard. I'm already looking forward to the 25th Reunion (25!!!). Keep the notes coming and let's build to a big turn-out in Cambridge in '80. — **Marc S. Gross,** 3 Franklin Court, Ardsley, N.Y. 10502; **Allan C. Schell,** 19 Wedgemere Ave., Winchester, Mass. 01890

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There are a number of notes in the mailbag. **David Staples** has been Headmaster of the Portledge School since 1970. . . . **Ben White** is now an enologist, working for Louis Martini winery. . . . **Jim Simmonds** writes us that he is a widower with two girls, aged 11 and 14, and is a Professor of Applied Mathematics at the University of Virginia. . . . **John Spencer** writes as follows: "Having completed my M.B.A. at N.Y.U. (evening classes stretched over five years), I am now entering a new field with the Equitable Life Assurance Society, currently as an agent. My year as Vice President for Programs for the M.I.T. Club of Northern New Jersey has just concluded. A busy one indeed! Now they have elected me Club President." . . . **Mel Ginsburg** is currently Geophysical Specialist with Exploration Services Center, a Division of Mobil Oil Corp. in Dallas, Texas. The Ginsburgs' first child, Jason Ross Ginsburg, was born May 21, 1974. . . . **Joe Rocchio** writes: "Our fourth daughter, Sheila Carolina, arrived early on Sunday, May 18, 1975, much to the delight of Mary, myself and her three sisters: Catherine, seven, Rosemary, six, and Eileen, four."

A retirement! Colonel **Mike McCarty,** who received his A.A. with us in 1957, retired in September of 1974, after 27 years in the United States Air Force serving in World War II, the Korean conflict and the war in Vietnam. He was stationed in Florida as Squadron Navigator and Engineer at the time of retirement. . . . **Allan Clark** has been appointed Dean of the Purdue University School of Science. Allan joined the Brown University faculty as an instructor in mathematics in 1961 and was promoted ultimately to full professor in 1970. He served as chairman of the Department of Mathematics at Brown from 1971 through 1974. He has been a visiting member of the Institute for Advanced Study at Princeton and a visiting Professor of Mathematics at Aarhus University. Most recently he served as Chairman of a faculty policy committee at Brown which assisted the president of that institution in carrying on difficult negotiations with the students and the board of trustees. Allan, selected after a student-faculty selection committee screened more than 100 candidates, is married, and the father of three children. . . . Ken Hickman, '56, has been named Vice President, Engineering of the O.E.M. Product Group at the York division of Borg-Warner Corp. Ken previously was Director of Engineering for O.E.M. In his new position he continues in charge of the development of all reciprocating and rotary compressors for air conditioning, automotive and refrigeration applications. He also directs development projects for marine engineering. Ken received his Ph.D. from the Case Institute of Technology, Cleveland. He is a member of the American Society of Heating, Refrigeration and Air Conditioning Engineers and the American Society of Mechanical Engineers, where he is active in the Fluids Engineering Div. He lives with his wife, Jeanne, and their three children in York, Penn.

Ben Chertok dropped us the following note: "We are completing an extended sabbatical year at the two-mile Stanford Linear Accelerator Center. I have been doing an experiment at SLAC, extending the deuteron's form factor to small distances by about a factor of four from previous investigations. We had a pleasant visit recently with **John Day** and family." . . . **Joe Leitgeb** is currently serving as M.I.T. Educational Counsellor for his area. . . . On October 12, 1974, **Richard Mortensen** was married for the second time. "My new wife is the former Sally Raulston Walker, whose hometown was Goldsboro, N.C. We are devoutly practicing Yoga and Meditation, in preparation for the coming Apocalypse." . . . **Dave Freeman** tells us he is happy with a new appointment as Professor of Chemistry at the University of Maryland, and with the sailing weekends on Chesapeake Bay! . . . **Arthur Cowen**'s card reads as follows: "I've been a stockbroker since 1968. I am presently with Shearson Hayden Stone, (212) 688-8000. I teach math in the evenings at Baruch School. The Chairman of the Department is **Hal Shane.** I also have been doing some tutoring in physics, chemistry and calculus. I'm finally beginning to understand them. I'm doing some volunteer work for the Lighthouse. Finally, I've taken up the sport of squash again which I first played at M.I.T." . . . Back in February I received a nice letter from **Alex Bernhard**: "I have been a Junior Partner at Hale and Dorr now for two years and have a general corporate practice. Hale and Dorr is a large law firm (about 85 lawyers) and I am on a number of committees within the firm, including one that has responsibility for the Associates. In this connection, I spent several days in New Haven last fall interviewing Yale law students (a very different atmosphere from the East Campus Parallels). I have also recently started doing some work with several Sloan School Alumni to give some legal framework to an alumni association for that school." . . . **Harold Miller** has been promoted to the position of Vice President and Director-Operations for I.T.T. Defense Communications Div. Harold was Vice President and Director, Program Management. In his new position he is responsible for organizing, planning, and directing the operations of the manufacturing, procurement and quality assurance functions. He was elected a Vice President of I.T.T. Defense Communications Div. in March. — **Fred L. Morefield,** Secretary, 285 Riverside Dr., Apt. 6A, New York, N.Y. 10025

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Our headline this month, for those that may not have heard the news, is that **Glenn Strehle** has been elected as Treasurer of the M.I.T. Corporation, effective this past July 1, succeeding Joseph J. Snyder who is retiring. Glenn has been a Vice President, Director and a member of the Executive Committee of Colonial Management Assoc., an investment advisory firm here in Boston. He has the broad financial experience needed to manage M.I.T.'s $344-million portfolio. Glenn and Kathy and their three sons will continue to live in Weston. Our congratulations to Glenn and good fortune in the tough task ahead.

Bob Ricci has been named a Sloan Fellow for the coming year with sponsorship by the U.S. Department of Transportation. He is currently serving as Chief of the Control and Simulation Branch at the Transportation Systems Center in Cambridge. Bob, Betty and their three girls live in Bedford. . . . Meanwhile, **Ken Langley** has just returned from "the real Cambridge in England where I spent a year's sabbatical working on studies of particle motions inside living cells using laser light scattering techniques." . . . Also fleeing England is **Ed Braman,** noting "we're celebrating our departure from the gracious life by sailing back on the *QE II;* then it's off to the wilderness of the Upper Peninsula of Michigan to Sawyer Air Force Base."

Richard File is becoming a mini-conglomerate in the Seattle construction market. At the moment, he is Vice President of F² Inc., a real estate development com-

pany, general partner of Westward Builders, a "spec" home building firm, and owner of R. P. File Construction Co., a custom home builder. Dick and his wife have three boys (seems like that's the class average this month) and have been in the Seattle area since 1968 when he received his M.B.A. from Stanford. . . . **Stephen Corman** is still with I.B.M. as a Senior Instructor in the Boston office where his wife, the former Betty Rubin, is a Systems Engineer, also for I.B.M. With no children (keeping down the class average), they have been traveling extensively for the past three years on vacations to Morocco, Majorca, Hawaii and sundry other garden spots. Between trips they can be found living in Wellesley. . . . **Robert Schmidt** states emphatically "our family is now complete! Last summer, Karen gave birth to our son, Peter, and Erica, age four, has become a big sister."

Harold Chapman is now the Radiological Training Officer for the California State Office of Emergency Services in Sacramento. . . . **Jacek Jedruch** is working on the design program for the Tokomak fusion test reactor to be erected at Princeton. . . . **Robert Wilcox** has been designated Counselor of Embassy for Scientific and Technological Affairs at the U.S. Embassy in Buenos Aires. . . . **Pete Peterson** has been named President of Softech, Inc., a Waltham-based firm specializing in development of advanced programming techniques. Pete had been Vice President and Chief Executive Officer prior to his new post.

It is my sad task to tell you of the death of **Warren Heimbach,** our Class Treasurer, last spring. His family and colleagues will miss him, as will our class which he served so well. At the time of his passing, Warren was deeply involved in the M.I.T. Special Gifts Program. . . . Many readers of this column will recall my report on alternative life styles and the adventures of **Neil MacFarlane** as a teacher and rag-time piano player in Italy. When a letter from his mother advised us of his death last year, we were indeed shocked but glad that Neil was doing what he had always wanted to do. Peace — **Michael E. Brose,** Secretary, 30 Dartmouth Street, Boston, Mass. 02116

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A mid-summer listing of our Class includes 1467 members (undergraduate and graduate) in 44 countries. If we receive just one item from each member during the next 5 years, we'll have news from 3 dozen people and one new country in each issue of *Technology Review.* This first column exceeds the average for both people and countries, so it's all downhill from here.

We celebrated our 15th Class Reunion in June, and it was enjoyed by a small but enthusiastic group of alumni and their families. The location was the M.I.T. campus, giving some their first look at the many buildings which have sprouted in the parking lots during the last 15 years. Awards for greatest distance traveled to the festivities, individual and family classes, went to **Eric Jorgensen** (Beaveron, Oregon) and to **Dan Mitchell** and family (Cedar Rapids, Iowa). Also in attendance for one or more events were **Anthony Anastation, Steve Bearman, Terry Bower, Joe Catanzaro, Ralph Cuomo, Shel Epstein, Stan Goodwin, Russell Hamon, Paul Heller, George Kirk, Bob Lagace, Bruce Layton, Steve Laveson, James Madden, John Maulbetsch, Sanford Miller, Mike Padlipsky, Milton Reed, Barry Rein, Bill Ross, Sue Schur, Al Shalleck, Joe Verderber, Sheila Widnall,** and **Len Youens.**

The election of class officers to five-year terms took place at the reunion dinner. After minor scuffling and debate — all by the electees — the slate was approved by unanimous voice vote. Your new class officers are **Ray Harlan** (President), **Ralph Buncher** (Vice President), **Tom Farquhar** (Treasurer), **Noel Bartlett** and **Burgess Rhodes** (Class Agents), and **Rob Stengel** (Secretary).

And now for news from our classmates: **Peter Silverberg** writes that he is the Insulation Engineer for the Electric Products Division of Portec, Inc., the Cleveland-based manufacturer of motors and generators. Pete finds Cleveland much to his liking, "a Midwestern twin to Boston, lacking only some of the historical flavor." (Is this the same Cleveland we all know and love?) . . . **Donald McElgot,** Professor of Aerospace and Mechanical Engineering at the University of Arizona, is moving to Karlsruhe, Germany for a year at the SFB-80-Institut Hydrodyhamik. . . . **Roger Stowell** is doing broad applied research at Fisher-Price Toys. Roger recently won first prize in a national creative ideas contest, "a whopping $2,500 scholarship for my two sons." . . . **Ed Aron** is now Vice President of Research and Development at Graphic Systems, Inc., a manufacturer of photo typesetting systems. . . . **Howard Hornfeld** has formed an independent plastics-market/technology consulting service in Geneva called CONSULTEX S.A. He was tired of the "rat race" with his former employer but now is running more than ever. . . . **Joseph Goldstein** has been promoted to full professor at Lehigh University. He has been performing research on samples of the moon rocks brought back on Apollo missions, and his professional interests include general physical metallurgy, x-ray analysis, and electron optics. . . . Our Athlete-of-the-Month Award goes to graduate alumnus **Tom Fitzgibbon,** who finished the 26-mile Boston Marathon (his fourth) in 3 hours, 10 minutes. Tom is Director of the Hybrid Computation Division at the Charles Stark Draper Laboratory. . . . **John Priest** is manager of financial analysis for polyolefins and polymer products at DuPont. . . . **Kurt Schwerdt** is with Raytheon in Wayland, Mass. . . . **Howard McDowell** is associated with a pulp and paper mill in Oregon.

Several notes came in with "regrets" for the reunion. **H. Joaquin von der Goltz** of Guatemala wrote that he would be in Austria, while **Donald Stelling** noted that it would be a long haul from Kusnacht, Switzerland.

Vernon Yoshioka, a Technical Specialist with Teledyne Ryan Aeronautical, sent a wealth of information. Vernon is engaged in a number of community activities, including the Manpower Area Planning Council of San Diego, a county vocational planning committee, a state advisory committee on civil rights, and the United Way of San Diego; he is also President of the local chapter of the Japanese American Citizens League, and Chairman of the Union of Pan Asian Communities of San Diego County. In his spare time, he sings tenor in the Silver Gate Sound, a barbershop quartet. When Vernon married his wife, Shinobu, in 1965, he gained an instant family with Charles, Carol, and Linda; their daughter, Christine, was born in 1967. . . . **Sheldon Epstein** is a patent attorney with the Brunswick Corporation and would like to hear from other lawyers in the class (Address: P.O. Box 400, Wilmette, Ill.).

Some months back, we received a note from a classmate who says "the 5-year remission period on my cancer does not end until August 27, 1975." Our hopes are with you.

I want to make a specific request for information: let's hear about careers, families, hobbies, opinions, and anything else that comes to mind. Have you found a comfortable niche or are you groping? How could the Institute and your class officers help? (Requests for miracles, funds, and faculty positions regrettably can not be processed.) This office should encourage and enhance communication among class members and the M.I.T. community, and this requires your support. We have 1421 class members and 40 countries to go. — **Robert F. Stengel,** Secretary, 152 Oxbow Rd., Wayland, Mass.

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Bob Johnson and his wife Julie adopted a baby boy, Alexander Keyes Johnson, born in March, 1975. Bob is still at DLJ, involved primarily with venture capital investments. . . . **William Pettus** is energy conservation coordinator at the University of California at San Diego. He would be interested in hearing from anyone involved in similar activities. . . . **Julian Ayres** graduated from Emory Medical School in June, 1975. He will intern at Grady Memorial Hospital for one year, after which he will be a resident in ophthalmology in the Emory University system. . . . **David Kelley** is also in Georgia, as an Assistant Professor in the School of Industrial Management at Georgia Tech. . . . And from **Dan Gourley** comes the following cryptic note: "Everything changes, form does not differ from emptiness, dS/dT = O." That sounds like it ought to mean something, but I'm not quite sure what it is.

The rest of my notes this month were somewhat longer — you're getting prolific in your old age. **Steve Rudnick** is Vice Chairman of region 04068 of the Alumni Fund Regional Organization, with responsibility for the Medfield, Mass., district. Steve is associated with the Department of Continuing Education at Northeastern and in addition is self-employed as a design consultant to the electronics industry. He is a member of the Medfield Democratic Town Committee and is otherwise politically active. Steve is a sponsor of the Metco program for integrated education, and his wife Lois teaches at the Boston campus of the University of Massachusetts.

William Hadden, Jr. writes that he has finally beaten the unemployment statistics and is teaching acoustics in the mechanical engineering school of Georgia Tech. (Look up **David Kelly** there.) Bill has had a summer grant from N.A.S.A. for the last two years, and has spent those summers in Virginia, with his folks. While he enjoyed the water sports and cruising he regrets leaving his work on his house and garden this summer. The Haddens enjoy the musical activities and other cultural activities in Atlanta, and are busy with their two children, Lucy, four, and one-year-old W. James IV.

David Claypool reports that he has recently changed jobs within Ethyl Corp. He is now Market Development Coordinator for Ethyl International. Although still headquartered in Baton Rouge, he will be spending some time in Europe and other parts unknown. . . . **George Duval** brings us up to date on his recent history with this note. He received his M.S.M.E. from M.I.T., in '66. From 1967-1969 he did work toward a Ph.D. at the University of Pennsylvania. He was married in 1965 and is now the father of three children, who are living in a house designed and built by their father over the 1972-75 period. George worked for the Navy (Naval Air Development Center) as an aeromechanical engineer from 1959 to this summer, but, his note adds, he is now quitting engineering to enter Medical School (general practice or orthopedic surgery) at George Washington University Medical School.

Gary Jensen is Associate Professor of Mathematics at Washington University in St. Louis. He asks the following philosophical question: "Does it make any sense to give money to M.I.T. when you work at another university?" He tells himself it's worth it to keep getting *Tech Review*, but says sometimes he'd feel more secure if he gave his small contribution to Washington University. . . . **Bob Edelson** informs us that a big event has been the birth of his number two daughter, Jennifer Marie, on February 2, 1975. Last year Bob was fortunate enough to be included in a N.A.S.A. Group Achievement Award presented to the Spacecraft Operations Team of the Mariner 10 project. Last May he was promoted to Manager, Advanced Projects in JPL's Data Acquisition Planning Office (the Deep Space Network). He'll be looking at how his organization will meet the needs of N.A.S.A. projects yet to take form. Sue, Sara, Jennifer and Bob are enjoying their California life, but still recall their East Coast environs fondly.

The final note this month comes from **Joe Goldfarb.** (Actually it comes from his wife Toni. Maybe if more spouses took matters into their own hands there would be more to read in this space each month.) The Goldfarbs are suburbanites, living in Teaneck, N.J., with their children, Lisa, six, and Seth, two and one-half. Joe is an Assistant Professor of Pharmacology at Mt. Sinai School of Medicine in New York City. He got his Ph.D. from Albert Einstein College of Medicine in 1969. Toni does medical research in the Department of Oncology (the medical science of tumor treatment — I had to look that one up in the dictionary) at Montefiore Hospital in the Bronx, N.Y.

End of notes, end of column. More next month. — **Mike Bertin,** Secretary, 18022 Gillman St., Irvine, Calif. 92664

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Hi! There's a bit of class news this month thanks to the backs of the alumni envelopes. . . . **Charles Abzug** is now Assistant Professor of Physiology at the University of Maryland School of Medicine. Another child was born to the Abzugs last year, so they now have three. . . . Another member of our class is teaching at Robert Wesleyan College in Rochester, N.Y. **Jim Bradley** is happy there with his wife and two children, and says he'd like to hear from ex-classmates. . . . **John Eulenberg** has also opted for the academic life. John is Director of the Artificial Language Laboratory at Michigan State University where he has been teaching and doing research in computational linguistics. The Eulenbergs have just added a new daughter to their household which makes them a family of four now.

Harvey Greenwald is an Assistant Professor of Mathematics at California Polytechnic State University at San Luis Obispo. . . . **Paul Holland** is still technical manager at Richardson and Holland Corp. in Gardena, Calif. He and his wife are proud parents of their first son. . . . **Jay Jaffe** recently formed Jaffe and Assoc., consulting actuaries with offices at 105 La Salle Street, Chicago, Ill. . . . **Emery Low** is now an Engineer Analyst at A.A.R. He just became engaged to Donna Berninger and they'll be married this fall. . . . **Jim McGaughy** is the proud papa of two sons. He is Nuclear Project Manager for Mississippi Power and Light Co. . . . Three children are the present family of Cecilia and **Raymond Smith.** Ray is an associate with Vessen Assoc. Inc., architects in Austin, Texas.

Your Secretary is in the process of changing jobs and moving to the Washington D.C. area, so the news this month will have to be short. Within a month or two, we should be settled down to a routine again, and I'll take a turn as class hero (write myself a letter) and tell you all about it. For the time being, keep that mail coming to 15 Apple Hill Road, and I'll get it one way or another. Ciao! — **Steve Schlosser,** Secretary, 15 Apple Hill Rd., Peabody, Mass. 01960

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The 10th reunion has come and gone, bringing a new set of class officers and a pile of mail. Our President is **Patricia Carr Erickson; Steve Lipner** has moved from Secretary to Class Agent and yours truly is the Secretary-Treasurer; Steve set a fine example that I hope to emulate. Steve has been with MITRE since 1969 and is currently at the Bedford office, in charge of all the computer security activities; he recently bought a condominium in Lexington and has sprouted a beard since I last saw him. . . . Janet and **Jim Wolf** wrote to announce the arrival of Sarah Baker Wolf to join three-year-old Josh; Jim has been with Booz, Allen & Hamilton since 1967. . . . **Greg Schaffer** was en route from Irvine to San Diego at reunion time. . . . **Sidney Wax** made it up from Mexico City. . . . The most impressive letter-head award goes to **George Gratsos,** who is President of Standard Bulk Transport Corporation of Athens, Greece. . . . **Charles Gholz** sent a nice letter; the Gholz family is moving into an old house in the D.C. area where Charlie is practicing law with Sughrue, Rothwell, Mion, Zinn & Macpeak. He sent word that **Bruce Sunstein** has acquired an M.A. in English and a law degree since leaving M.I.T. Bruce is now practicing law in San Francisco. . . . **Bill Brody** is still in Bethesda, at the National Institutes of Health. . . . **Jim Taylor** is with Exxon, at last word as Division Employee Relations Manager in Corpus Christi, Texas.

John Edgar has been promoted to major in the Air Force and by now expects to be at the Air Command and Staff College at Maxwell A.F.B., Ala. . . . **John Chiappetta** is in Denver, working on synthetic fuel problems with the Stearns-Roger Corp. and enjoying the Colorado outdoors. . . . Some academic promotions of note include **Arnold Abrams** to Assistant Professor of Pathology at the U.S.C. School of Medicine and Director of Pathology at the Southern California — U.S.C. Cancer Center; and **Rowland Cannon** to Assistant Professor of Ceramics at M.I.T.

Several classmates have written books. **Bill Loomis,** who is an Associate Professor of Biology at U.C.-San Diego had a book on *Dictyostelium Discoideum: A Developmental System* published by Academic Press. (It is all right; I did not understand it either.) . . . **Fritz Steele** had two books out this year: *The Open Organization* was published by Addison-Wesley and *Consulting for Organizational Change* by the Univ. of Massachusetts Press. . . . **Michael White** is on the faculty at Syracuse, where he is a professor of public administration and associated with the Health Studies Program. Michael has co-edited *Cases in Public Management* (Rand McNally) and *Management of Policy Sciences in American Government* (D. C. Heath) and also had his Ph.D. thesis published by Heath. . . . **Ralph Cicerone** was honored as the Outstanding Young Engineer of the Year by the Detroit Engineering Society in June.

That finishes the mail-bag, folks. Your letters or notes on the back of Alumni Fund envelopes are crucial. If you do not write I may be reduced to telling St. Bernard stories! — **Edward P. Hoffer,** Secretary, 12 Upland Rd., Wellesley, Mass.

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We gathered with approximately 150 other people recently in San Francisco to attend a dinner sponsored by the M.I.T. Club of Northern California, and to attend the San Francisco Symphony conducted by Arthur Fiedler. **Bob Ramers,** who was elected president of the club for the coming year, promised additional social activities. . . . **Fred Kuttner** is working on a Ph.D. in theoretical physics at University of California at Santa Cruz. Fred writes that he and Marleen recently found the Lord Jesus and "the peace that passeth understanding." The Kuttners have two daughters, Shoshana and Emily. . . . At last report **Michael Zuteck** was still working at T.R.W. Systems in Houston, although cutbacks had reduced employment from 1000 to 100 and another cut was expected. He and **John Ebert** went skiing for a week at Aspen last winter. Mike is building a custom Toronado catamaran. . . . **Ting C. Pei** is vice president of the real estate development firm of Sefrius Corporation, a subsidiary of Union Internationale Immobiliere of Paris. . . . **Jerry Yochelson** is director of research and development for American Totalisator Systems, Inc. . . . **Harvey Deitel** passed his C.D.P. exam last winter. He teaches at Bentley College. . . . **James Sweeney** runs a successful custom woodworking business. . . . **William Lange** has been promoted to Director of Economic Analysis for Pan Am World Airways. . . . **Mike Crane** works at Control Analysis Corporation in Palo Alto and teaches part time at Stanford. His free time is spent restoring a Victorian house in San Francisco. . . . **George Thomas** will be a visiting scientist at Osaka University, Osaka, Japan, for the 1975-76 academic year. . . . **Gerald Lisowski**

received his Ph.D. in organic chemistry from the University of Wisconsin and is now employed by the Agricultural Chemicals Division of Stauffer Chemical Company in Richmond, Calif., where the mild weather of the San Francisco Bay area is a welcome change from the frigid temperatures of Madison. — **Jim Swanson,** Secretary, 669 Glen Road, Danville, Calif. 94526

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Greetings again as we begin the eighth year of our almost-monthly gossip and news column. As usual let us remind you that *you* are our major source of news. So if you like to read the column drop us a note every now and then. If you combine with a gift to the Alumni Fund you don't even have to pay postage. The news this month is a combination of items that fell between the cracks last spring and what has been accumulating over the summer. . . . **Sue Downs** writes that she received her doctorate in Engineering Economic Systems at Stanford last spring and is now an Assistant Professor in the Operations Research and Statistics Department at the *Institute Européen d'Administration des Affaires* in Fontainebleu, France. . . . Meanwhile, **Dan Harris** is moving back to California after two years of a postdoc at the Albert Einstein School of Medicine in the Bronx. He received the 1975 Meller Basic Medical Research Award for his work and is about to have a book published entitled *Symmetry and Spectroscopy*. Dan is taking up a position as assistant professor of chemistry at University of California at Davis. He reports the birth of a second son, Douglas, last May. . . . **Bob Young** reports that he is quite busy fixing up a 100-year-old house that he bought a year and a half ago. . . . We have three items from the physicians in our class. **Tessa Orellana** finished her residency at Childrens' Hospital Medical Center in Boston in June, 1974 and is now doing a fellowship in Infectious Diseases at the University of Chicago. She's spending the first two years in the lab working in Epstein-Barr virus transcription and will do the clinical training after that. . . . **Harry Goldmark** finished a residency in general surgery at New York Hospital in June and now has a residency at the Hospital for Special Surgery in New York in Orthopedic Surgery. He was married in June, 1974 to Nancy Seligman. . . . Back in Boston, **Dan Green** has finished a residency in Pediatrics at Boston City Hospital and now has a fellowship in Hematology-Oncology at Boston Children's Hospital. . . . **Phil Sikes** is studying Biomedical Engineering at Marquette. He previously worked in plant engineering and fibreglass polyester mold tooling design at Contemporary Products, Menomonee Falls, Wisc. and studied M.E. at night at Marquette. . . . **Anthony Trojanowski** is studying for a Ph.D. in Math at U.C.S.D. where he is doing research in combinatorics and computer science. . . . In London, **Pete Amstutz** is working for the Merchant bank and studying to be a Chartered Financial Analyst. He previously spent five years on Wall Street in research and in international corporate finance, including one year working with the Japanese. He adds that his list of languages now includes Italian.

Stephen Wilson has been promoted to Assistant Professor of Math at Princeton. He spent last year on leave at the Institute for Advanced Studies and at U.C.S.D. . . . **Dave Ellis** is an attorney with R.C.A. Global Communications in New York. He recently wrote an article on communications satellites for the technical publication, *RCA Engineer*. Dave lives on Long Island with his wife, Sue, who is a doctoral student in Psychology. . . . **Robert Terry** is working on a thesis in plasma physics at the Johns Hopkins University Applied Physics Laboratory in Columbia, Md. . . . **Natalie (Weiss) Holzworth** finished her thesis in solid state physics at the University of Chicago and has been working on a postdoc at the University of Toronto. She hopes to get a job in the New Jersey-New York area so she can rejoin her husband there. . . . **Dave Cook** has succeeded in moving away from the University of Toronto, but not very far, to the Division of Cardiology at the Hospital for Sick Children in Toronto. He is now Assistant Director in the expanded cardiac records and evaluation center overseeing development and epidemiologic studies. . . . From Albuquerque we got an interesting note from **Dave Pearson** who at the time was working for General Research Corporation but who has since moved to Sunnyvale, California to work for Electromagnetic Systems Labs. He writes that his "primary interest (outside of miscellaneous skiing, sailing, tennis, and hiking) has been understanding and modeling the economic/political mess that has resulted in the last 30 years from growing government size and the resulting loss of individual control." . . . **Gene Stark** reports the birth of a third son, Nathan, last January. Gene's working for the new Technology Liaison Office at Los Alamos, which is responsible for accelerating the utilization of the lab's technology and generating external perspectives on their work by promoting and executing close interaction with industry and other non-federal entities.

Closer to home, **Al Currano** is working at the Johns Hopkins Applied Physics Lab on computer-aided design of digital systems, and L.S.I. and microprocessor simulation and description. When he wrote he had two children; "L'il Al," 2, and Becky, 1, but a third was expected shortly. He reports having a great time backpacking five days in Yosemite a year ago, "with seven-week-old Becky in Mom's pack." . . . **Emil Friedman** is a Senior Research Chemist at Goodyear Tire and Rubber where he reports meeting many other alumni. . . . After receiving a Ph.D. from Harvard Med in Physiology, **Richard O'Dessey** took a two year postdoc in muscle metabolism. Now he's in the Department of Physiology at U. of Virginia's School of Medicine in Charlottesville and is looking forward to hearing from other alumni in that area. . . . **Charles Thorn** has been named an Alfred P. Sloan Research Fellow in the M.I.T. Department of Physics. He was one of 78 young scientists who were selected nationwide for this program, which encourages basic research by young faculty members. . . . And that brings us up to date for the new year. See you next month. — **Gail** and **Mike Marcus,** 2207 Reddfield Dr., Falls Church, Va. 22043

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I'm your new unofficial Class Secretary. I wrote a letter to *Technology Review* complaining about the infrequent class news, and was informed our Class Secretary was out of pocket and that **Howie Segal** has been writing the news as often as he can. Please keep the information coming in and I will do my best to write something every month.

Jerry Kardas writes that he has been at Pratt and Whitney as an analytical engineer since June, 1973, in the Inlet and Nozzle group. His wife, Jan, is now in the process of writing her master's thesis in ethnomusicology at Brown University. He invites us all to stop by and visit him in Ashford, Conn. . . . **Ed Turner** and Joyce will be leaving Pasadena and moving to Princeton, N.J., for a two-year post-doctoral appointment at the Institute for Advanced Study. . . . **W. A. Platte** is a Commanding Officer, U.S. Naval Air Facility, Sigonella, Sicily, since September, 1974. . . . **Vincent J. Mannoia, Jr.** writes: "After M.I.T. I attended St. Louis University Graduate Program in Philosophy of Science ('71-'72), married Ellen Schroeder in August, '72 (a German and a Sicilian — wow), transferred to Washington University (also in St. Louis) where I finished my Ph.D. last week! Miraculously found a job teaching Philosophy, Philosophy of Science and guess what — *Physics* at Grover City College." Good luck, Vincent.

Henry E. Snelling reports he is alive and well at Tuskegee Institute serving as the Associate Clinic Director of the John A. Andrew Clinics doing over-all systems development for a large-scale primary health care network. . . . **Larry Donovan** is now Director of Ocean Facilities for the Naval Facilities Engineering Command in Washington, D.C., after serving three years as Head of the Ocean Construction Project Office. . . . **Vikas P. Sukhatme** plans to complete his Doctorate in Physics by September of this year and then enroll at Harvard Medical School as an M.D. candidate in the Harvard-M.I.T. Program in Health Sciences and Technology. . . . **David C. Morris** is now in Algiers working for S.O.M.: Cite Universitaire for 6,000 students. . . . **James L. DeLucas** writes: "After leaving M.I.T. in '71, I attended the Air Force Institute of Technology graduate school, receiving an M.S. in Aerospace Engineering in May, 1973. I then worked as an Aero Engineer at Eglin A.F.B. in the Maverick missile program. I was married in June, 1973, and I am now attending the University of Alabama Medical School."

Wedding bells rang for **B. R. Roberts** in Roselyn, N.Y., when he was married to Judith A. Higgins (Vassar '69). They are moving to Manila, Philippines for 18 months where he'll be helping in the planning and design of the water supply system. He received his Engineer Degree at Stanford this past April. . . . **Charles W. Werner** is working on his doctorate at the Tute and living at 32 Commonwealth Ave., Boston, telephone: 267-4781. . . . **Thomas R. Gilbert** is a member of the Research Div. at the Boston Aquarium, where he is presently principal investigator for a contract study of trace metal transport in natural waters. His wife, Donna is a graduate of Rochester Institute of Technology and is active in arts and crafts in the Norfolk area. . . . **J. M. Karz** writes: "I will receive my M.D. degree from the Albert Einstein College of Medicine in June, 1975 and will begin an internship in straight medicine at Presbyterian University Hospital, University of Pittsburg Medical Center. After the 'small matter' of intern-

ship is completed, I will be in Boston in July, 1976, to begin a four-year research-oriented radiology residency at the Peter Bent Brigham Hospital. Friends (and enemies) can reach me at the above address after" — unfortunately the address was not on the part the Tute sent me. If you want an address included in your message, please put it on the "news for Class Secretary" part of your contribution card. . . . **Stephen Lawrence Hauser,** received his M.D. degree (magna cum laude in a special field) from Harvard Medical School — congratulations. . . . **Stephen W. Ryder** received his M.D. degree from Case Western Reserve University and starts his first year graduate training in Internal Medicine at Hartford Hospital, Hartford, Conn. . . . **J. Andreas Howell** is a member of an Aerospace Defense Command squadron which has earned the U.S. Air Force Outstanding Unit award; he is an Orbital Analyst with the 1st Aerospace Control Squadron which received the award for exceptionally meritorious service. . . . That's all the news for this month. I'm starting my third year at law school at Southern Methodist University in Dallas. Texas is a great place. — **Hal Moorman,** 3461 McFarlin, Dallas, Texas.

72

Just got a letter from **Hugh** and **Eve Sprunt** today. "The bay area is full of M.I.T. grads, some working, some still in school. To us most of them appear to be crew jocks or S.A.E.'s. Eve has just completed her coursework and is now working full time on her doctoral thesis in the Stanford Geophysics Department. She hopes to be done in a couple of years if her pressure vessels survive. I was promoted to Lieutenant, senior grade in the commissioned corps of the National Oceanic and Atmospheric Administration this spring and was pleased to have my resignation accepted at the same time. Working for the government was a strange but informative experience. My duties, on two deep ocean research vessels have taken me to South America, Africa and a variety of islands in the Atlantic and Caribbean over the last three years. Eve and I are looking forward to living in the same place for the first time since our marriage in January, 1973 when I begin a M.B.A./J.D. Joint Degree Program at Stanford this fall."

A few short notes: **Bostjan Vilfan** is Assistant Professor of Computer Science at the University of Ljubljana, Yugoslavia. . . . **Marina Paige Bartley** graduated from Villanova Law School in May and will be entering practice with the firm of J. Taney Willcox, Jr. in Narberth, Penn. after taking the bar exam. . . . **Ric DiCapua** writes, "You thought the 'tute was hard. Just come to Harvard Business School. It isn't a picnic either." . . . **William DePietro** is married and a junior at Georgetown Medical School. . . . **Hiroshi Komine** married Yuriko Kubota last year and is continuing toward a Ph.D. in applied physics at Stanford. . . . **Nathaniel Mass** was appointed assistant professor at Sloan, and also edited *Readings in Urban Dynamics,* just published. . . . **Phil Lambe,** finishing his M.S. in Civil Engineering, is working in his father's geotechnical consulting business and spent the summer working in Venezuela. . . . **Eric Westberg** is working at Angra dos Reis, Brazil with Westinghouse as a project engineer on Brazil's first nuclear reactor. His daughter, Veronica, was born in Rio de Janeiro in March, 1974. . . . **Walter Miller** is working for Spectra-Physics, in Mountain View, Calif., as a manufacturing engineer in charge of dye lasers and other laser related products. He was married in August 1974 and received his M.S.E.E. from Stanford in June, 1973. . . . The Air Force hometown news center would like us to know that **Paul Hooper** finished his pilot training at Moody A.F.B. in Georgia and is headed next to Laughlin A.F.B. in Texas. . . . and that **James Mosora** finished a communications course in Keesler A.F.B. at Biloxi and will be posted at Offutt A.F.B. in Nebraska, with the Strategic Air Command.

Our Far Eastern correspondent, Shabbir Nomanbhoy, '73, reports that he and Amin Lukhani spent part of their summer touring northern Pakistan. Amin is back in Cambridge now at Harvard Business School, and Shabbir expects to be returning to the University of Michigan.

Rafael Fernandez writes, "Punted an engineering job at Westinghouse in Tampa and am going to Stetson Law School while working on my own pool business. My regards to the rest of the bro and the Class of '72." . . . Robert Goodof, '73, notes, "I've been working happily for 'daddy' Dow Chemical for nearly two years in plastics research and development. Saw **Dave Gilen** in Chicago recently but have otherwise been working steadily and fixing up a house I bought. I'm selling real estate on the side." . . . **D. S. Gnanamuthu** reports that he is a senior staff metallurgist at Avco Everett Research lab working on surface alloying and hardfacing using Avco H.P.L. lasers. These are capable of high output (more than 10 kw) and have been used in welding, cutting, and transformation hardening of many parts for autos, trucks, aircraft and ships. . . . Finally, **Pat Currie** writes, "I recently returned from the 'far reaches' of the Amazon, under the auspices of the University of Wisconsin Sea Grant Program. I'm currently out of school and out of money, but plan to have a good season down at Arlington Park in Illinois (the horse don't you know.)" So, folks, it's back to the track until next month. — **Dick Fletcher,** Secretary, 135 West St., Braintree, Mass. 02184

73

After more than a year's absence, the Class of '73 notes have recovered from a lack of news and my hectic schedule. The material, however dated, is plentiful.

Two writers among our classmates: **Bill Elkus** wrote an article entitled "Prisoners Potentially Rehabilitated by Transcendental Meditation" in the March 15, 1974, issue of the *Harvard Law Record*. . . . The December *If* Magazine carried **Dan Dern**'s first published work, a science fiction story. After working as a technical writer for Honeywell last year, Dan "split to hitch to California" over the summer; he is now back in Cambridge working on his second science fiction novel.

As you all probably know by now, **Greg Chisholm** was elected to the Corporation last year as a representative from recent classes. He "would appreciate any thoughts or inputs which the members of the classes '72, '73, and '74 might have." Write him at Bell Laboratories, Inc., Dept. 3314, 2525 Shadeland Ave., Indianapolis, Ind. 46226. . . . **David Wilson,** who ran this year for a similar Corporation position, married Michele Miller in April, 1974, and is currently employed by the Corning Glass Works of Corning, N.Y. . . . **James Reuss,** who was nominated to be a Corporation representative, was a systems analyst at St. Louis University and a member of the Board of Directors of Midwestern Time-Sharing Interface Corporation before starting medical school this fall.

From sunny California we hear word of **Richard Haas,** who is at U.C. San Francisco Medical School; **Francis Keil,** who is getting his Ph.D. in developmental psychology at Stanford; and **Kevin Clougherty** and **Cynthia Stratton,** who received M.B.A.s from Stanford. Cyndy will be working on the tax staff of the Houston office of Ernst & Ernst after graduation. And at Berkeley **Mike Scott** is getting his M.B.A., **Lewis Held** is working on his Ph.D. in molecular biology, and **Steve Waller** is in a joint Doctor of Optometry - Masters in Physiological Optics program. **Richard Schechter** left the University of North Carolina and began graduate studies in psychology at U.C.L.A. this fall.

In even sunnier Florida, **George Smith** received an M.E. degree from the environmental Engineering Department of the University of Florida this June and was looking forward to finding a job in the north "where there are seasons." . . . **Steven Nadler** finished his second year of medical school at McGill, and **David Moylan** is enjoying his medical studies at Georgetown. . . . **Richard Galik** writes, "Things are proceeding well here at Cornell in my doctoral program in physics. I won a Cornell Fellowship and may even get my degree by mid-'78. What free time I have I spend on the lacrosse coaching staff and playing intramurals." . . . **Henry Feuerstein** started Columbia Law this fall.

Three M.I.T. representatives at Yale have written. **Dean Kross** is "studying hard but finding plenty of time to play at the Yale Medical School Country Club;" **Steven Warsof** is in his second year in Medical School and "working diligently on our Second-Year Class Show, a parody on medical school entitled 'Dyspareunia is better than no Pareunia at all.' " . . . **Doug Levene** is "spending my days wrestling demons and pursuing an utterly useless but occasionally interesting masters degree in East Asian studies. [I] am especially into Japanese language and medieval Japanese history. The professors are excellent by and large, but I do not like Yale — it's too straight and Ivy League."

Robin Waldron is studying astronomy-cum-physics at the University of Massachusetts in Amherst. . . . **Karl Gallegos** is a second-year student at Harvard Medical, and **Steven Richardson** started at Harvard Business School this fall. He married Susan Cappe (Simmons) in June, 1973. This summer he worked at H.B.S. on a computer program "to adjust corporate accounting for inflation." . . . **Irving** and **Jean Paskowitz** were due to complete Master's programs at Washington University last fall. Irv is working full-time for Monsanto and taking an evening M.B.A. program. Jean was working part-time at Monsanto but was expecting a member of the class of 1997 in February. . . . **Ed Fenstermacher** is working in microwave acoustics research at the Air Force Cambridge Research Labs. He is taking

flying lessons and has applied for his first patent. . . . **Paul Ahrens** is working for Allied Chemical at the Chemical Processing Plant at the National Reactor Testing Station in Idaho Falls, Ida.

Michael Locey is teaching physics and physical science at Berkman High School, Gwinnett County, Ga. . . . **Thomas Warren** completed two years of service at Bell Labs and participated in the Operating Company Assignment Program this spring. . . . **Phil Fuhrman** is "at Hewlett-Packard's Analytical group in Avondale, Penn., applying microprocessors to laboratory instrumentation." . . . **Michael Knauer** is the Educational Applications Project Leader at Digital Equipment Corp.; he married Kathleen Barton (Bridgewater State '73) in December. . . . **Robert Thomas** writes that he is currently a manager in the Rate Planning Division of the Revenues Department ("where Ma Bell raises your rates") of the Chesapeake and Potomac Telephone Co. . . . **Greg Daley** is "working for Phillips Petroleum as a Project Engineer for the Ekofisk North Sea - offshore drilling and production facilities. Now residing in Bartlesville, Okla." . . . **Jon Andresen** is a Research Analyst for a Department-of-Transportation-funded freight car truck design optimization project. . . . **Alan Lehotsky** is working for Hewlett-Packard on medical computer systems. His wife, the former Susan Hayes, and he are both taking advantage of New England sports — hockey, mountain climbing, and buying gasoline. . . . **Peter Guldberg** and his wife Alex will be celebrating their second anniversary August 19. After a wedding in the Chapel they moved to Ann Arbor where Peter got his master's in atmospheric science from the University of Michigan. He is currently working in air pollution research for Walden Research Division of Abcor.

Sally Boyson writes that she and her husband John Fetrow live in Philadelphia, where John is finishing his second year at the Pennsylvania Veterinary School and she has been working as a Junior Research Specialist in physiology and pediatrics at the University of Pennsylvania. She expected to start at the medical school in September, an event which both were anticipating — "John so he'll have peace to study, and me so I'll have to think more than 5 per cent of the time." . . . **Joel Bergman** is working as an operational auditor for Blue Cross-Blue Shield of Greater New York. He is a member of the Educational Council and refereeing hockey. . . . **Philip Sadler** spent a year at Harvard Graduate School of Education getting an Ed.M. in psychology, administration, and children's television and is teaching and developing curriculum at the Carroll School in Lincoln, Mass. He built a 16-foot steel and plastic geodesic dome with a group of 13-year-olds — "most interesting project so far this year." . . . **Alan Lawee** is back from a year's stint in Europe and is presently working in Montreal as a research analyst at Canadian Pacific, Ltd. He is enjoying the skiing, taking night courses and "generally keeping busy." . . . **Arthur Barber** was deployed to the Mediterranean as Operations Officer on the *U.S.S. Alacrity* and reported to the *U.S.S. Kinkaid* in January, 1975, as fire control officer in the precommissioning crew. . . . **Matthew Wolfe** married Christina Miller in June, 1974.

Ed Weinberger is a devotee of Guru Maharaj Ji and has been for about two years: "He is showing me a practical method for attaining true peace of mind, true happiness, and the experience of love." . . . **Michael Lipchak** recently moved to Natick with his wife Dorothy (B.U. '73) and one-and-one-half-year-old daughter, Maggie. He has worked for Raytheon since graduation and they have been financing his return to M.I.T. for a Master's since last fall.

And finally, congratulations to those of you who received advance degrees from the Institute this year. Among the familiar names and faces last June were: **John Avallon, Paul Battaglia, Paul Bayer, Michael Binder, Richard Charpie, Greg Chisholm, Will Cummings, Christos Demetriou, William Frenkel, Donald Grossman, Adela Hadiwono, Michael Harris, Ping-Tong Ho, Danny Lee, James Osborn, David Oyer, Anthony Pellegrino, Wade Pitts, Meredith Porter, Stephen Roy, Mary Jean Schmutz, Paul Shapiro, William Short, Robert Silberstein, David Stolpher, Doris Taam, Stuart Traver, David Wilson, Kok Yu,** and **Charles Zierling.**

I hope this column is the start of a good habit — you send me news, I'll write a column. Peace — **Joy Judell,** Secretary/Treasurer, 1156 Commonwealth Ave. #58, Allston, Mass. 02134

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Dave Bernstein has completed his first year in the M.B.A. program at Stanford Business School. . . . **Larry Brazil** is a graduate student at Colorado State University. . . . **Richard Hartman** is now attending the University of Missouri Columbia Medical School. . . . **William Biemann** is "assistant coordinator for development of a Manganese Nodule Exploration System and Bore Hole Probes using Activation Analysis Technique." The letter was bearing a postmark from Germany — however, there was no mention of being in Europe. . . . **Rick Corey** is "working in Immuno-Pharmacology on mice" at Yale Medical School. . . . **Allen Gerstenberger** is "still smiling."

David Vogel was married to Deborah Sakey, a graduate of Simmons College, on May 11. David is studying bio-medical engineering at the University of Michigan. . . . **Steve Weinstein** and his wife Robin just bought a house in Amsterdam, N.Y. Steve is working as an industrial engineer for Mohasco Corp. and is also working toward an M.B.A. at Rensselaer Polytechnic Institute. . . . **Ludwig Chang** has been appointed Business Manager for Doubleday Advertising Co., Inc. . . . **David Aldrich** has been awarded the first John W. Simpson Westinghouse Fellowship in Nuclear Engineering by the American Nuclear Society. The fellowship, worth $7,000, will be used for his Master of Science program in nuclear engineering at M.I.T. — **Dennis Dickstein,** Secretary, 16A Forest St., Apt. B1, Cambridge, Mass. 02140

75

For this first 1975 Class Notes column, I had hoped to be able to present some statistics on what members of the class are doing with themselves now. Unfortunately, my deadline for this article was somewhat earlier than I had expected, and the Career Planning & Placement Office had not yet compiled the information I needed. However, I did manage to obtain some information from the Preprofessional Office. Roughly 2 per cent of the class are going to law school this fall and 8 per cent are off to medical school. (Didn't it always seem like more than 8 per cent?) So that means the other 90 per cent of us have jobs or are in other graduate programs. Hope to have more info next time.

Of those classmates attending medical school this fall, I've heard from **Greg Rothman** who is at New York University School of Medicine and **David Kerski** who is in Madison, Wisc. at the University of Wisconsin Medical School.

I've heard from several classmates regarding their present employment. **Robert Paine** is working for Environmental Research and Technology in Concord, Mass. He writes, "My work involves monitoring analyses and prediction of atmospheric pollutants by means of meteorological forecasts." Hope he lets us know when and where to get our gas masks. . . . **David Kelly** tells me he has returned to sunny southern California where he is employed at the U.C.L.A. Brain Research Institute. . . . **Michael Kozinetz II** is working for the Badger Co., Inc., Cambridge, Mass., as a Field Construction Management Trainee. . . . **Gerald E. Liebold, Jr.** has joined The Bankers Life, Des Moines, Iowa, as an E.D.P. Programmer. . . . I heard via a clipping from the *Concord Patriot* that **Dick Lambe** is now employed by the geotechnical consulting firm of Woodward-Clyde whose home office is in Chicago. According to the article, "Since much of Woodward-Clyde's work is on projects in Iran, Saudi Arabia, and Alaska, Dick plans to keep his suitcase packed."

Jeffrey Lang of Lincoln, Mass., was named recipient of the Schlumburger Foundation Fellowship in the Department of Electrical Engineering and Computer Science here at M.I.T. for the 1975-76 academic year. . . . For those of you who expected to see **Margo Levine** out at Berkeley, Calif., this year, you're in for a disappointment. Margo has decided to remain at M.I.T. and hopes to gain February admission to the Alfred P. Sloan School of Management. . . . Wedding bells rang in Shrub Oak, N.Y., on July 27 for **Sue Fuhrman** and Larry Lasky, '72. I saw the happy couple the day after the big event and they were off to Maine for their honeymoon. Then it's back to the University of Michigan where they both attend medical school for another year and after that, who knows? By the way, Sue intends to keep her own name, "despite the hassles." Right on, Susie!

In response to a letter that was sent out to the class this past spring from **Anita Horton, Ilene Gordon,** and myself, I had four people volunteer to be my Regional Representatives. They are **Allen Muhic** in Ohio, **Judy Fairchild** in California, **Tom Hui** in New York, and **V. "Woody" Priebjrivat** in Thailand. I will print their addresses in my next column, as at present I have not confirmed these. In the future, you can channel your news to these people if you're in their area or you can write to me directly or to the M.I.T. Alumni Association. I look forward to hearing from you. Hope you all had a good summer. — **Jennifer Gordon,** Secretary-Treasurer, 5 Centre St., Apt. 32, Cambridge, Mass. 01239

Before the smoke cleared, our chemists went to work...

It was the worst communications fire in U.S. history. The blaze, in one of the world's largest telephone switching centers, silenced more than 170,000 phones covering a 300-block area of New York City.

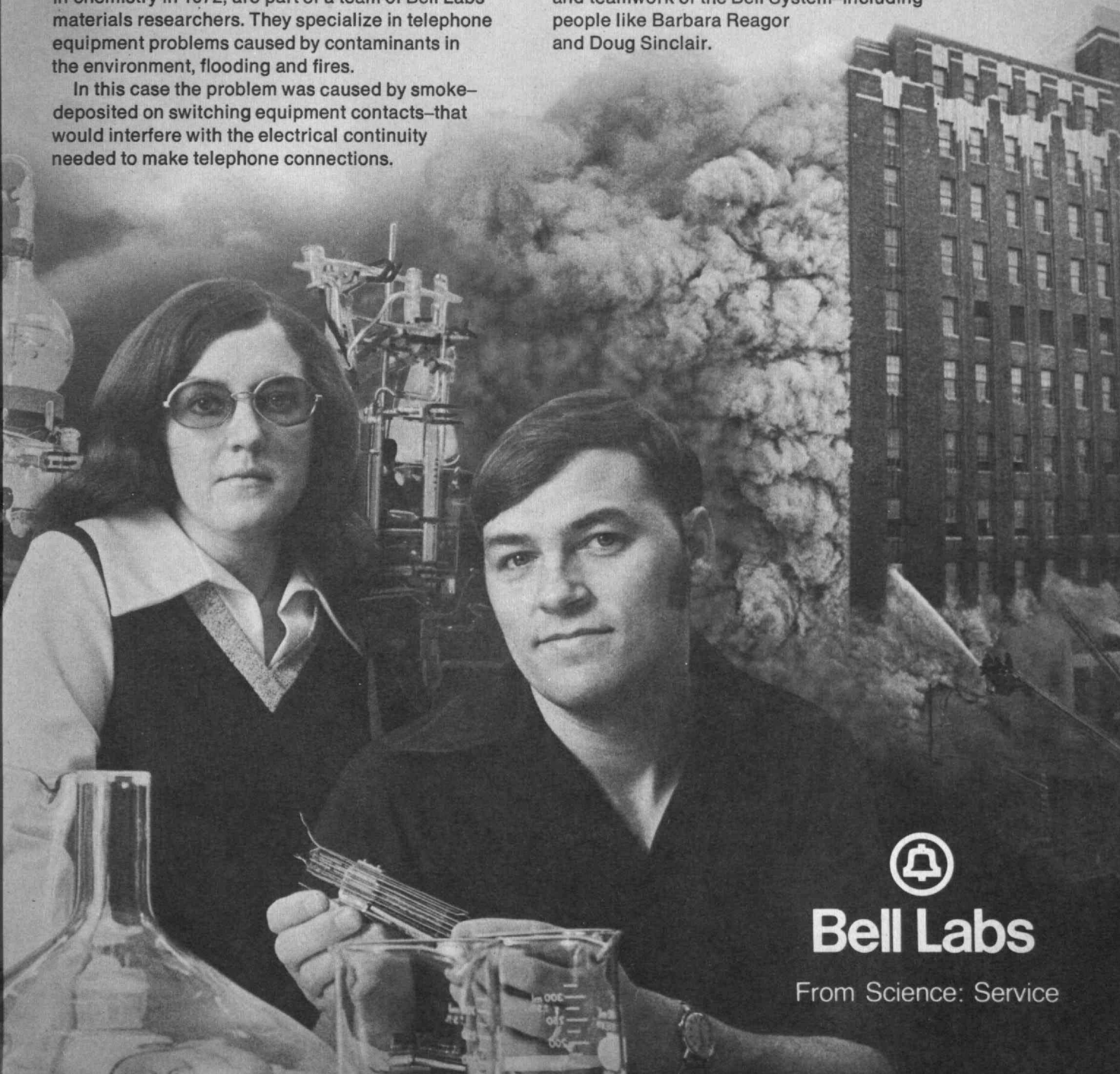
But while the fire was still burning out of control, the Bell System mobilized to restore service, and people from the New York and other Bell System companies, AT&T, Western Electric and Bell Labs jumped in to help. People like Barbara Reagor and Doug Sinclair.

Barbara, who is working toward her master's in chemistry, and Doug, who received his Ph.D. in chemistry in 1972, are part of a team of Bell Labs materials researchers. They specialize in telephone equipment problems caused by contaminants in the environment, flooding and fires.

In this case the problem was caused by smoke–deposited on switching equipment contacts–that would interfere with the electrical continuity needed to make telephone connections.

In the laboratory, Barbara used a scanning electron microscope with an X-ray fluorescence detector to analyze samples of the smoke deposits. And at the fire site, Doug collected samples and tested methods of removing the smoke from the contacts. The answer: dissolving the deposits with trichloroethane. This procedure was used by craftspeople to clean the more than six million switching contacts in the building.

The fire is already history. Telephone service was restored in just over three weeks–a task that ordinarily would have taken over a year. It was an achievement made possible by the combined resources and teamwork of the Bell System–including people like Barbara Reagor and Doug Sinclair.



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